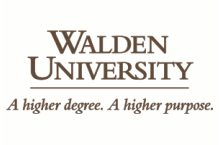

2020

Barcode Medication Administration in the Emergency Department to Mitigate Medication Errors

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This is to certify that the doctoral dissertation by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
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Walden University
2020

Abstract

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by

Holly E. Gauthier-Wetzel

MSN, Walden University, 2011

BSN, Capital University, 2007

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Nursing

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Abstract

Electronic health record systems (EHRs) have been adopted in healthcare facilities to unify the workflow process of healthcare professionals. Studies have demonstrated the addition of barcode medication administration (BCMA) software technology within the EHR has decreased medication errors within hospitals and long-term care facilities. However, limited research has been conducted to establish whether using BCMA in outpatient areas has had an influence on medication error rates. Literature reveals that many facilities have not adopted BCMA in outpatient areas. The purpose of this study was to investigate whether medication errors were mitigated after BCMA was implemented in the emergency department (ED). Transitional Care approach was used to analyze patients who were seen in the ED, ordered to receive medication in the ED, then transferred to an inpatient area within the same facility. Using quantitative nonexperimental method, retrospective data were collected from the organization's corporate data warehouse. The results of these analyses indicated a reduction in medication administration errors for the studied population after the facility implemented BCMA in the ED. Additional findings include medication documented as given without the presence of a written medication order and the absence of standardized medication administration documentation practices after the implementation of BCMA in the ED. Facilities may benefit from the results of this study by exploring reasons nursing staff choose not to use BCMA correctly which may increase quality outcomes.

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Dedication

To my father who encouraged me to take this journey, my husband who has reignited my gift of life, and my children who have always had faith in me.

Acknowledgments

I would like to express my deepest gratitude to my committee chair, Dr. Donna Bailey, who has provided hours of guidance as well as personal and professional encouragement. I sincerely appreciation the countless number of hours my co-chair, Dr. Camilla Jaekel, contributed to help me attain my dream. Finally, I am grateful to have a tremendous amount of support and encouragement from Dr. Charlene Pope. I admire each one of you and feel blessed to have you as part of my life journey.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Healthcare providers are challenged every day with the task of delivering the highest quality and safest patient care possible. Yet, according to McCann (2014), over 400,000 lives are lost each year as a result of medical errors. Errors involving medication administration are included within the annual report of medical errors (McCann, 2014). Medication errors account for approximately a quarter of all adverse events that occur within a hospital environment (Covell & Ritchie, 2009). According to the United States National Coordinating Council for Medication Error Reporting and Prevention (2015), a medication error is defined as "a preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer" (para 1). Medication error events can be devastating and can take place during any step in the medication process (Berdot et al., 2016).

The steps involved in the medication process involve prescribing, transcribing, dispensing, administering, and monitoring (Harkanen, Ahonen, Kervinen, Turunen, & Vehvilainen-Julkunen, 2014). The medication process is a very complex task and may involve the use of complex EHR systems (Harkanen et al., 2014). The development and implementation of information technologies, such as EHRs, were introduced to assist providers in preventing errors, including medication errors (Berdot et al., 2016). Interestingly, even though EHR systems have been adopted in healthcare facilities throughout the country, one of the leading causes of serious harm is fragmented care

related to medication administration errors (Stewart, Snodgrass, Schontz, & Parekh, 2015).

The purpose of this study was to investigate whether medication errors decrease after documenting medication administration within an electronic nursing note was replaced by documenting medication administration using BCMA software technology. BCMA software is integrated into the facility's EHR system. Data regarding medication errors while documenting medication administration within an electronic nursing note located within the computerized patient record system (CPRS) and medication errors while documenting medication administration using BCMA software was collected and analyzed. This study includes information obtained from records of patients who were observed in the ED, had medication(s) ordered to be administered in the ED, and transferred to an inpatient unit within a VA Medical Center located in the Southeastern United States.

To address this gap, I have completed a quantitative nonexperimental comparative descriptive research design study using retrospective data. Data was obtained by reviewing patient records within CPRS at the VA Medical Center where this study took place. I collected, analyzed and compared data before BCMA software technology was implemented within the ED, at which time medication was documented in an electronic nursing note located within CPRS, and after the implementation of BCMA software began documenting medication administration in the ED.

Quantitative research designs are often used to investigate causal relationships but may also be used to investigate relationships between variables (Gray, Grove, &

Sutherland, 2017). The study conducted was a descriptive design because the data was not manipulated, and no interventions or treatments were made to the information obtained. Descriptive designs are considered nonexperimental (Gray et al., 2017). A comparison was made to examine the relationship between the dependent variable (DV), medication error, and the independent variables (IVs), using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit. After collecting data, I used Chi-square statistics to identify the comparison between the DV and IVs. Therefore, I conducted a quantitative nonexperimental comparative descriptive research design using Chi-square statistics to identify whether the use of BCMA in the ED mitigates medication errors for patients that were prescribed medication to be given in the ED prior to transferring to an inpatient unit within the VA Medical Center where this study took place.

Safe patient care has long been the focus of social change throughout the United States (Kohn, Corrigan, & Donaldson, 2000). This study contributes information that may improve our standards of care regarding technology as a means of documenting medication administration in outpatient units such as the ED. According to Glover (2013), many facilities that use BCMA technology in their inpatient units have not implemented BCMA technology in their ED.

The electronic exchange of information allows continuity (the ability to engage in the electronic exchange of medication information throughout the facilities) within the patient record (Wolfe, 2008). Not using BCMA in all patient care areas that administer

medication within a facility may result in an interruption within the patient's EHR (Glover, 2013). Without this informational continuity within the patient EHR, there may be a greater possibility that medication errors will occur for the patient transferred from the ED to an inpatient unit.

This study may have an influence on positive social change because it demonstrates the results of two system processes. These processes include documenting medications ordered to be administered in the ED for patients that are transferring to an inpatient unit within an electronic nursing note located in CPRS compared to documenting medications to be administered in the ED for patients that are transferring to an inpatient unit using BCMA software technology. Positive social change will be influenced by the study outcome relating to medication error rates between these two documentation processes.

In the rest of this chapter, I provide a summary of research literature related to the scope of this study, a description of the gap in knowledge related to this study, the reason for this study and the study problem statement. I will provide the intent of the study with an overview of each variable, the research question, and the null hypothesis for this study. I identify and define the conceptual framework used as it relates to the research question. Next, I will state the rationale for design selection as well as summarize the methodology which shall be used for patient record selection to be collected and analyzed. Variables and terms used will be defined, assumptions, scope, boundaries, and

limitations will be identified. Finally, the significance of the study toward the advancement in healthcare knowledge will be described.

Background

BCMA is a software technology that uses barcoding as a form of identification within an automatic data-capture technology system (Staggers, Iribarren, Guo, & Weir, 2015). BCMA is integrated within the EHR and includes barcoding patients' wristbands and medications (Staggers et al., 2015). Barcodes that are affixed to medications and patient wristbands help ensure a match between patients and their medications at the time of drug administration (Dubin, 2010).

Using BCMA software allows the nurse to electronically validate the medication provided to the patient is correct. The BCMA electronic process involves the provider logging into the BCMA software (by using provider-specific access and verify codes), scanning the patient's wristband, which then generates the patient's electronic medication administration record within the BCMA software system, and scanning the ordered medication(s). This method has been shown to decrease medication errors within the inpatient units of the hospital and long-term care facilities (DaSilva & Krishnamurthy, 2016; Glover, 2013; Kelly, Harrington, Matos, Turner, & Johnson, 2016; Radwin, Castonguay, Keenan, & Hermann, 2016; Shaw, Lo, Babich, Tsao, & Bansback 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). Lack of continuity within the EHR creates an interruption within the patient's EHR (Glover, 2013). Without continuity within the

patient EHR, there may be a greater possibility that medication errors will occur for the patient transferred from the ED to an inpatient unit.

Defining the Gap

According to a study conducted by the U.S. Centers for Disease Control and Prevention (2017), an estimated one in five Americans will visit an ED each year. This study indicated that out of the 145.6 million hospital ED visits, 16.2 million resulted in hospital admissions and 2.2 million resulted in critical care unit admissions (Centers for Disease Control and Prevention, 2017). Between the years 2007 and 2017, ED visits have increased an estimated 24.46% throughout the United States (Kaiser Family Foundation, 2018). The identified increase in ED visits may cause concern for a potential increase in medication errors.

The ED is a fast-paced healthcare environment and medication administration can be time-sensitive. Instructions for the administration of medication within the ED are generally ordered to be given now, stat, on call or one time as opposed to inpatient units. Medication orders written in an inpatient setting are generally ordered to be given at specific scheduled times. The most susceptible units for medication errors tend to be high demand units that provide care to patients with more complex and severe diagnoses such as the ED (Medicacao, 2015). Limited research has been completed regarding the use of BCMA within the ED (Glover, 2013). This study explored whether the frequency of medication errors decrease after implementing BCMA technology in the ED.

Problem Statement

Prior to using BCMA to document medication administration in the ED, the nurse was able to document medication administered in the ED within an electronic nursing note located within CPRS. This electronic nursing note has no required field to document the five rights of medication administration which are recommended to reduce medication errors (Grissinger, 2010). The five rights of medication administration include verification that the nurse has the right patient, right drug, right time, right dose, and right route prior to giving a medication to a patient. The five rights of medication administration are regarded as the standard of safe medication administration (Grissinger, 2010). BCMA technology standardizes the medication administration process by using scannable barcodes. Barcodes are located on a patient wristband and all medication packages. By scanning the barcode, the five rights of medication administration are executed, and the medication automatically populates as given within the EHR which reduces variations in the documentation. Inaccurate and/or incomplete medication documentation may lead to an omission or duplication of ordered medications (Hummel, Evans, & Lee, 2010). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013).

Medication errors can occur during all phases of patient care (Medicacao, 2015; Vilena, & Jerico, 2015). The most susceptible units for medication errors tend to be high demand units that provide care to patients with more complex and severe diagnoses such as the ED (Medicacao, 2015). According to DaSilva and Krishnamurthy (2016), the ED is the third most common hospital unit that medication errors occur. Therefore, it is

vitally important that all patient care information is communicated when the patient is transferred to another unit for care.

BCMA software is part of the patient's EHR. The use of BCMA has been demonstrated to decrease medication errors within hospitals and long-term care facilities (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert, Maddox, Flynn, & Williams, 2014; Shaw et al., 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). Lack of continuity within the EHR may pose a greater risk for medication errors to occur for patients that have had medication ordered to be administered within the ED and have transferred from the ED to an inpatient unit (Glover, 2013). This study investigated medication error rates for two time periods which included medication errors that occurred while documenting medication administration within an electronic nursing note located within CPRS compared to medication error rates that occurred while documenting medication administration using BCMA software. This study was conducted at a VA Medical Center located in the Southeastern United States.

Gap in Literature

Hospital facilities have been known to have separate documentation processes for medication administration in the ED compared to inpatient units (Glover, 2013; Hummel et al., 2010; Pevnick et al., 2018). Without the integration of a medication software system (such as BCMA technology) in the patient EHR, medications administered in areas that do not use BCMA will not automatically transfer to the patient electronic medication profile when the patient is admitted to an inpatient unit (Bridgeman & Rynn,

2008). Lack of electronic continuity within the EHR may result in increased medication errors. According to the American MEDMARX database, 21% of reported medication errors were associated with the prescription phase, 22% of the reported errors were associated with the medication delivery phase and 33% of the reported errors were associated with the medication administration phase (Berdot et al., 2016). The final step in the medication process, administration, is considered the least studied phase of the medication process and is the last protective step between the medication and the patient prior to the patient outcome (Berdot et al., 2016).

A large percentage of medication errors are the result of administering medications at various times throughout a patient's hospital stay (Hummel et al., 2010). A deviation from the provider's medication order for the patient is considered an administration error (Berdot et al., 2016). Inaccurate and/or incomplete medication lists may lead to the omission or duplication of ordered medications (Hummel et al., 2010). Literature indicates that additional research is needed to investigate whether standardized documentation processes of medication administration within EHR systems (such as BCMA technology) for patients transferring from the ED (an outpatient unit) to an inpatient unit increases patient safety by decreasing the number of medication errors (Pevnick et al., 2018).

Purpose of Study

BCMA is a software technology that is integrated within the EHR at VA Medical Centers throughout the country. Using BCMA software allows the nurse to electronically validate the medication provided to the patient is correct. The purpose of this study was

to investigate the comparison of medication errors after documenting medication administration within an electronic nursing note was replaced by documenting medication administration using BCMA technology.

To address this gap, I conducted a study using a quantitative nonexperimental comparative descriptive research design. A comparative descriptive design is used when two distinct groups are described and compared in terms of their retrospective variables (Gray et al., 2017, p. 204). This study measured medication error rates that occurred while documenting medication administration within an electronic nursing note located within CPRS compared to medication error rates that occurred while documenting medication administration using BCMA within a VA Medical Center located in the Southeastern United States. I collected, analyzed, and compared data before and after the implementation of BCMA in the ED. Examination of data signifies whether medication errors occurred more or less frequently when an ED nurse used an electronic nursing note compared to BCMA software to document medications given in the ED for patients ordered to receive medication in the ED then transfer from the ED to an inpatient unit at the VA Medical Center in this study.

Variables within Study

The two primary types of variables are DVs and IVs. The DV is the variable the investigator attempts to explain within the outcome of the research study (Gray et al., 2017). The DV in this study was medication error. An IV is a variable that can be influenced or manipulated (Gray et al., 2017). The IV affects the DV. The IVs in this study were the methods of medication administration documentation practiced in the ED

for patients that were ordered to receive medication in the ED then transferred to an inpatient unit at this VA Medical Center. The first IV is the use of an electronic nursing note located within CPRS to document medication administration in the ED and the second IV is the use of BCMA software technology to document medication administration in the ED. The use of scannable barcodes is the foundation of BCMA software technology.

Research Question and Hypothesis

Research Question (RQ) 1: What is the comparison in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit?

$H_0$1: There is no relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

H_a1: There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

Theoretical Framework

Transferring a hospitalized patient from one care area to another has proven to be a complicated process (Cacchione, 2016; Naylor, 2000). According to Kulshrestha and

Singh (2016), transfer documentation is the most important part of the patient transfer process. However, documentation that accompanies a patient is often overlooked because patient transfers are often unorganized. Kulshrestha and Singh (2016) suggest that a standardized document that includes the patient's full name and condition, the reason for the transfer, names of referring and receiving providers, vital signs, clinical events and treatments given should accompany every patient transfer. However, studies have demonstrated that the receiving unit may be unaware that documentation records have traveled with a patient (Kulshrestha & Singh, 2016). Therefore, Hammond (2015), suggests the transferring area complete a face to face transfer of care to the receiving area.

The use of EHR technology, such as BCMA, provides authorized user immediate access to the patient information (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2015; Shaw et al., 2016; Staggers et al., 2015). Therefore, the EHR should be a constant record of patient care. Hammond (2015) suggests that providers should consider patient care as a ‘continuum’ of care status rather than ‘inpatient’ and ‘outpatient’ care status. Continuum of care is sometimes considered Transitional care (Hammond, 2015). By using the continuum philosophy, providers may be able to anticipate the patient's needs as they move through that continuum instead of discharging from one status only to admit them into another (Hammond, 2015).

Successfully transferring patient information from an outpatient setting to an inpatient setting, while sustaining the highest quality care, involves teamwork from all disciplines caring for the patient (Naylor & Berlinger, 2016). Studies have demonstrated

that medical errors have decreased when providers effectively communicate patient information from one level of care to the next (Kennelty, Witry, Gehring, Dattalo, & Rogus-Pulia, 2016). Therefore, healthcare organizations must ensure that patients are not exposed to risks such as communication errors as patients transfer from one care area to the next (Mueller, Zheng, Oray, & Schnipper, 2018; Naylor & Berlinger, 2016). Each healthcare worker involved with the patient transfer contributes to safe and timely transfer of care as well as helping control financial and emotional costs associated with patient care (Naylor & Keating, 2008).

Most often the reason a patient is transferred from one care setting to another is that their medical care needs have changed to a greater or lesser monitoring status (Cacchione, 2016; Delboccio et al., 2015; Kulshrestha & Singh, 2016; Naylor, 2000; Naylor & Keating, 2008; Rezapour-Nasrabad, 2018). The theoretical base for this study was Transitional Care Theory, specifically the Transitional Care Model. This model targets the older adult population and the continuity of care (CoC) delivered by various disciplines throughout the patient's hospital stay (Hirschman et al., 2015). Transitional Care is a recognized evidence-based approach for improving care provided during patients transitioning between care settings (Hirschman, Shaid, McCauley, Pauly, & Naylor, 2015; Naylor, 2000; Rezapour-Nasrabad, 2018). Transitional Care Theory is used to increase outcomes for patients who transfer from one care setting to another (Hirschman et al., 2015).

The Transitional Care Model was created and developed by Dr. Mary D. Naylor, with the assistance of a multidisciplinary team at the University of Pennsylvania School

of Nursing (Cacchione, 2016). Originally Transitional Care Model was used for cardiac patients, however, after diligent study, Dr. Naylor enforced the need for use with patients who have been diagnosed with multiple chronic conditions (Cacchione, 2016; Naylor & Keating, 2008). Hospital studies have demonstrated that the quality of patient care and patient outcomes improved, and patient care costs decreased after the hospital had implemented the use of Transitional Care Model within their care facility (Cacchione, 2016).

Transferring a patient from one care area to another has proven to be a complicated process because it involves transferring information between two units (Cacchione, 2016; Kulshrestha & Singh, 2016; Naylor, 2000). Both care settings must communicate with one another and provide complete documentation and verbal information to ensure a safe patient transfer (Kulshrestha & Singh, 2016). Transitional Care emphasizes continuity, coordination, relationships, engagement, collaboration, and education (Cacchione, 2016). The Transitional Care Model incorporates each component within the patient transfer process. Without these communication components, patient care may suffer, and errors may be more likely to occur (Cacchione, 2016; Naylor, 2000).

Noncollaboration among healthcare providers has been recognized as a serious problem associated with negative outcomes among hospitalized patients that transition from one healthcare setting to another (Hirschman et al., 2015). Approximately 13-20% of preventable older adult rehospitalizations have been associated with limited follow-up, poor CoC, and gaps in services as patients move between healthcare providers and across care settings (Hirschman et al., 2015). Transitional Care Theory is designed to help

prevent communication breakdown between healthcare providers (Naylor, 2000). Supporting Transitional Care Theory with the use of health information technology (such as EHRs) may help prevent gaps in inpatient care services, increase care quality and improve patient outcomes (Hirschman et al., 2015).

When a provider uses BCMA software to document medication administration, another provider can immediately identify medications that have been administered to a patient (DaSilva & Krishnamurthy, 2016; Radwin et al., 2016). When the nurse does not use BCMA software to document medication administration, the following nurse (or provider) must look within an electronic nursing note and search the note for documentation confirming whether medications were administered to the patient (Staggers et al., 2015). This form of medication review may take several minutes which may delay treatment (Staggers et al., 2015).

Nurses have been known to miss documenting medications administered to their patients (Di Simone et al., 2018). If there is no documentation of an administered medication, the patient may receive two doses of the same medication. The lack of an appropriate transition of care puts the patient at risk. With the use of BCMA software, the receiving nurse has immediate access and may view all medications administered by the previous nurse in real-time (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). Without continuity within the patient EHR, there may be a greater possibility that medication errors will occur for the patient ordered to receive medication in the ED then is transferred from the ED to an inpatient unit that uses BCMA technology.

Conceptual Framework

During the past decade, patients are spending less time in hospitals, have a greater number of healthcare disciplines managing their care, and expect more from hospitals coordinating their care (Minvielle et al., 2010). To obtain and sustain high-quality medical care, there must be a method of communicating patient information from one healthcare professional to another. When healthcare providers use the CoC concept, they are practicing a communication strategy necessary to coordinate patient care that could result in a less fragmented exchange of information (Minvielle et al., 2010). This CoC technique may provide a means to improve patient safety and increase the quality of patient care.

According to Reid, Haggerty, and McKendry (2002), the CoC measures consists of the chronological order of the healthcare provider's contact with a patient. In a conference held for the Canadian Health Services Research Foundation, the Canadian Institute for Health Information, and the Advisory Committee on Health Services of the Federal/Provincial/Territorial Deputy Ministers of Health (2002), CoC was recognized for concepts which included the duration and frequency of patient and provider contact, how informed providers are in regards to the multiple providers caring for the patient, and the extension of care completed from one provider to the next.

Multiple studies have found that poorly managed health records are the leading cause that often results in low-quality patient outcomes and human and economic suffering (Hirschman et al., 2015). A contributing factor of poorly managed patient care is that patient information is often conveyed directly from one provider to the next

(Pereira, M., Furegato, & Pereira, A., 2005) rather than documenting patient care within the patients' EHR. The provider that verbally receives patient information, during the exchange of patient care from one unit to the next, may not be the provider that is tasked with caring for the patient. This type of information exchange may lead to medication errors.

One of the leading causes of serious harm is fragmented care related to medication administration errors (Stewart et al., 2015). Furthermore, medication errors are considered a primary focus of quality-improvement initiatives within healthcare institutions (Berdot et al., 2016). According to the Institute of Medicine (2008), medication errors have decreased since the adoption and use of BCMA software within healthcare settings. BCMA may be considered a component of CoC because providers can immediately view medications documented as administered within the software technology system. By implementing a system to create and sustain CoC throughout the patient care continuum, a facility may have the means to deliver higher quality care and increase the potential for positive patient outcomes. CoC can be considered an antidote to fragmented care by forming the basis for assuring that all providers involved in a patient's care share important clinical information.

Nature of Study

I used a quantitative case study design which included retrospective CPRS chart reviews, medication errors reported to the patient safety hotline and joint patient safety report (JPSRs) reviews before and after the implementation of BCMA in the ED at a VA Medical Center located in the Southeastern United States. The study involved one site

and used naturalistic data; therefore, case study designs were an appropriate approach for this comparative descriptive design (Harrison, Birks, Franklin, & Mills, 2017). CPRS chart reviews helped to examine medication errors for patients who were ordered to be given medication in the ED, then transferred to an inpatient unit. Data obtained during the time period when documenting medication administration in an electronic nursing note within CPRS was compared to using BCMA software to record medication documented as given in the ED. CPRS chart reviews provided information regarding medication errors between using BCMA and not using BCMA in the ED. The patient safety hotline is a method used to report safety issues (including medication errors) at this location. All reported medication errors are reviewed by the patient safety coordinator and documented within an excel spreadsheet. This spreadsheet is kept in a password protected firewalled server folder. The JPSR system was initiated into this facility in the Winter of 2018. Administration and end-users are able to report patient safety events by submitting an electronic JPSR. No medication errors were reported through patient safety hotline or JPSRs for the time periods specified prior to and after BCMA software technology was implemented in the ED at the VA Medical Center. This quantitative nonexperimental comparative descriptive research study was conducted to investigate how the DV, medication error, was affected by the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit.

Methodology

Binomial distribution (comparing two proportions) of the denominator (number of medication orders) and numerator (number of errors) was conducted to determine the number of patient records needed for the research study. With significance level α=0.05, equal sample size from two proportions (r=1), the probability $p_1 = 0.33$ and $p_2 = 0.165$ are considered sufficiently different to warrant rejecting the hypothesis of no difference. Then the required sample size for two arms to achieve an 80% power (β=0.2) can be determined by $M = 118$, $N = 236$. The symbol p_1 and p_2 represents the proportions of event interest for each timeframe within the study. According to the American MEDMARX database, 33% of reported medication errors were associated with the medication administration phase prior to using BCMA software technology (Berdot et al., 2016). In previously cited studies (Poon et al., 2010; Thompson et al., 2018), the use of BCMA software technology reduced medication errors by 50% on average (41.4% to 55.4%). Therefore, $p_1 = 0.33$ and $p_2 = 0.165$ were used, respectively. Equal charts were reviewed for both pre-BCMA and post-BCMA timeframes, therefore $r = 1$. To ensure an adequate amount of data was collected, an additional 11 charts per timeframe were reviewed. This resulted in a total sample size of 258 charts for the study.

Patient records reviewed for the study consisted of patients who had medication(s) ordered to be administered within the ED prior to patient transfer to an inpatient unit at a VA Medical Center. I selected a confidence interval of 95% which suggests that there will be a 95% probability that the interval contains the population parameter and that there is a 5% risk that the population parameter is not contained

within the interval (Frankfort-Nachmias & Leon-Guerrero, 2015). BCMA software technology was implemented in the ED at this VA Medical Center in the Fall of 2017. I utilized Structured Query Language (SQL), a standard computer language that is used to manage and manipulate relational databases (Zentut, 2020), to conduct the patient record inquiry by extracting data from the Corporate Data Warehouse (CDW) for records of patients that were observed in the ED and ordered to receive medication in the ED prior to transferring to an inpatient unit.

Data Analysis

In a quantitative research study, it is important to acquire information that can be duplicated as well as generalizable (Creswell, 2014; Leedy & Ormrod, 2001). A sample size estimation for proportion (Shuster, 1990) was used to estimate the number of patient records needed to obtain results reflecting the target population for this study. I used a confidence interval of 95% which suggests that there is a 95% probability that the interval contains the population parameter and that there is a 5.0% risk that the population parameter is not contained within the interval (Frankfort-Nachmias & Leon-Guerrero, 2015). A lower limit and an upper limit represent a range of values that denote the true population parameters with a specific level of confidence (Frankfort-Nachmias & Leon-Guerrero, 2015).

Data analysis consisted of analyzing information entered into the Statistical Package for Social Services (SPSS) software system (data collection) using the Chi-square test of independence. For the Chi-square test, a bivariate table presents the distributions of two categorical variables simultaneously, with the intersections of the

categories of the variables appearing in the cells of the table (Number Crunchers Statistical Software, n.d.). The Chi-square is used to assess whether an association exists between the two variables by comparing the cell pattern of the observed counts to the anticipated pattern that is expected if no relationship exists between the variables (Number Crunchers Statistical Software , n.d.). The result of the Chi-square compared against the value from the Chi-square distribution allows the researcher to assess whether the observed data are significantly different from the expected data (Number Crunchers Statistical Software, n.d.). All cells had an expected frequency value of 5, which validates no violation of the Chi-square test assumption. Chi-squared statistics were used to determine the comparison in medication errors between documenting medication ordered to be administered in the ED by using an electronic nursing note in CPRS and documenting medications ordered to be administered in the ED by using BCMA software technology.

Definition of Variables

Medication error (DV): Medication error is defined by the United States National Coordinating Council for Medication Error Reporting and Prevention (2015) as

> any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labeling, packaging,

> and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use. (para. 1).

A medication administration error consists of giving an incorrect dose, incorrect route, incorrect time, administering the wrong medication or not administering a medication that was ordered to be given (error of omission). Medication errors are operationalized within this study as with medication error (WME) and, no medication errors are operationalized within this study as without medication error (WOME).

Electronic nursing note located in computerized patient record system (IV): Also called a Progress Note, an electronic nursing note is a document used by healthcare providers to enter an electronic patient progress note within the patients' healthcare record (Department of Veterans Affairs Health Data System, 2019. p. 255). All computer authorized caregivers that have a legitimate reason to view the patient record may review the transcribed nursing notes after the writer has signed the note as complete (Department of Veterans Affairs Health Data System, 2019. p. 255). Components of the nursing note consist of subjective and objective information as well as the nursing plan of care (Department of Veterans Affairs Health Data System, 2019. p. 255). The electronic nursing note, which is located within CPRS, is operationalized within the report as Group *A*.

Barcode medication administration (IV): A technological enhancement incorporated within an EHR that helps to ensure the correct medication is administered to a patient (Bowers et al., 2015). The BCMA electronic process for medication administration involves the nurse logging into the BCMA software by using their

provider specific access and verify codes. Then, the nurse administering the medication will scan the patient's wristband which will generate the patient's electronic medication administration record within the BCMA software system. Next, the nurse will identify the patient by using two patient-specific identifiers (such as full name, full date of birth or full social security number) and verify the patient identification matches what is displayed within BCMA. After reviewing the medication due list displayed in BCMA, the nurse will scan the medication, look at the BCMA screen, view whether the medication was marked as given and continue to scan the next medication. If the scanned medication does not match the ordered medication, a 'do not give' warning message will populate in BCMA alerting the nurse that the medication scanned is not correct. Finally, the nurse will assure the patient ingests the scanned medication. BCMA is operationalized within the report as Group *B*.

Terms and Acronyms

Barcode: A set of lines with various widths and sizes that identify data distinctively unique to the item that the barcode is printed, stamped or embossed on. Barcoding is used as a form of identification within automatic data-capture technology systems (Staggers et al., 2015). Barcodes that are affixed to medications and patient wristbands help ensure a match between patients and their medications at the time of drug administration (Dubin, 2010).

Bar code medication administration (BCMA): A healthcare technology system that includes barcoding medication (Staggers et al., 2015). This system has been recommended to aid with the proper identification of prescribed medication (Dubin,

2010). BCMA is primarily used to assure the 5 rights of medication delivery are followed (Staggers et al., 2015).

Computerized provider order entry (CPOE): Also known as *computerized physician order entry* or *computerized practitioner order* entry, refers to a healthcare technology system that allows the provider to enter and send orders and treatment instructions through an integrated electronic system (Khanna & Yen, 2014). An integrated patient record system which allows providers the ability to manage patient care records and access patient information (Khanna & Yen, 2014).

Corporate Data Warehouse (CDW): The information storage system which compiles and organizes data for all Veteran Affairs Medical Centers (United States Department of Veteran Affairs, 2014). A clinical database consisting of standardized and consolidated and clinical data. Data can be extracted, after permission has been granted for access, and analyzed (United States Department of Veteran Affairs, 2014). The evaluation of data can provide useful information for organizational improvement.

Computerized Patient Record System (CPRS): The Veterans Health Administration adopted a CPOE system (Staggers et al., 2015). CPRS is a component of the government agency's healthcare network, VistA, which provides a client/server interface for healthcare providers to view and update Veteran's EHR (TechTarget, 2019). CPRS is used in both the VA medical centers and outpatient care clinics. Clinical documentation modules used within this CPOE include laboratory tests, MRI, patient care diet orders, and e-prescribing (TechTarget, 2019).

Electronic health record (EHR): An electronic version of a patient's medical record. The EHR has been adopted to allow secure real-time patient record viewing to authorized users (Staggers et al., 2015).

Emergency Department (ED): A term used interchangeably with emergency room (Di Simone et al., 2018). The ED at the VA Medical Center where this research took place, has 18 private rooms which are staffed and equipped to provide initial evaluation, treatment, and disposition for a broad spectrum of illnesses, injuries, and mental health disorders, regardless of the level of severity (Floyd, 2019). The ED operates jointly with the 152-bed inpatient tertiary care service that serves over 80,000 patients along the Southeastern coast providing emergency care is 24 hours a day, 7 days a week (Medical University of South Carolina, 2018). The facility is a level 1A facility, providing service to patients with the most complex level of care (Medical University of South Carolina, 2018).

Emergency Department Integration Software (EDIS): An extension to CPRS and created by Veterans Integrated Services Network, EDIS helps track and manage the flow of patient care within an ED setting (Department of Veteran Affairs, 2019). Information may be configured to a site-specific view. The CDW extracts all information entered within the EDIS software system (Department of Veteran Affairs, 2019). An application that helps by electronically managing the care of patients in the Emergency Care System. The application improves ED care by reporting patient status information systems within an electronic program (Department of Veteran Affairs, 2019).

Emergency Room: A term used interchangeably with the ED (Di Simone et al., 2018). A unit in a hospital that is staffed and equipped to accept and treat people with traumatic injuries or illnesses that require immediate medical attention (Di Simone et al., 2018).

Error of omission: A patient care duty to be performed that is either omitted or delayed. (Laws & Hughes, 2018).

Five Rights (5 rights): Recommended to reduce medication errors, the five rights: right patient, right drug, right time, right dose, and right route (Grissinger, 2010). Many healthcare professionals regard 5 rights as the standard for safe medication administration (Grissinger, 2010).

Joint patient safety report (JPSR): An online application that allows healthcare providers to self-report patient safety events that have occurred which may or may not have resulted in patient harm (Military Health System, n.d.). Employees at VA Medical Centers throughout the United States use this system to report medical errors and safety events within the work environment (Military Health System, n.d.).

Medication Administration Process: The medication administration process is a step in the medication process (Lee, B., Lee, S., Bum, & Ji, 2015). It is the last chance to prevent actual harm to patients in the medication process (Lee et al., 2015).

Medication error (DV): According to the United States National Coordinating Council for Medication Error Reporting and Prevention (2015), a medication error is defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional,

patient, or consumer." (para 1). The preventable event may or may not cause harm to the patient and can occur at any stage of drug therapy related to professional practice, healthcare products, procedures, and systems, which may or may not cause harm to the patient (Sawarkar, Keohane, Maviglia, Gandhi, & Poon, 2012).

Medication Process: The steps involved in the process of medication administration. The steps include prescribing, transcribing, dispensing, administering, and monitoring (Harkanen et al., 2014). A very complex task which may involve various disciplines such as medical doctors, pharmacists, and nursing staff (Harkanen et al., 2014).

Patient safety hotline: A facility-wide posted phone number (hotline) used prior to January 1, 2018. Designated for staff, patients, visitors, or family members to report patient safety events. The phone line was monitored by the patient safety coordinator. The patient safety coordinator documented all reported patient safety events within an Excel spreadsheet. This spreadsheet is named 'calls' and is located in a folder that is password protected and behind a firewalled server.

Stabilization period: Customer support, data integrity, and system stability are more carefully monitored during a system install and the following four to 6-weeks after the system has been established (Gibson, 2013). The stabilization period is the time allowed between a new system install and when end-users become proficient and comfortable using the new system (Gibson, 2013).

Structured Query Language (SQL): A standard computer language that is used to manage and manipulate relational databases (Zentut, 2020). SQL can be used to retrieve

subsets of information from within a database for analysis. Queries, written as commands, are made within SQL program to acquire information (Zentut, 2020). Commonly used commands include select, from, add, and insert.

Veteran Affairs (VA): A federal agency that provides healthcare services to eligible military Veterans (Van der Veen et al., 2018).

Veterans' affairs medical center (VAMC): A medical facility managed by the VA (Van der Veen et al., 2018).

Veterans Health Administration (VHA): America's largest integrated health care system (United States Department of Veteran Affairs, 2019). The VHA consists of 1,255 health care facilities which include 170 VA medical centers and 1,074 outpatient care clinics (United States Department of Veteran Affairs, 2019).

Veterans health information systems and technology architecture (VistA): An integrated database and application server that maintains inpatient and outpatient Veteran health information (Haun et al., 2015). VistA's integrated system includes CPRS, BCMA, electronic prescribing, clinical guidelines and business information (Haun et al., 2015). The VistA platform consists of hardware and software packages that support the clinical and administrative needs of the system-wide VA EHR system (Department of Veteran Affairs Health Data Systems, 2019). This nationally used closed-looped architecture system confirms the match between medication orders, medication preparation (including dispensing), and patients receiving medications (Haun et al., 2015).

Assumptions

Assumptions are required elements in a proposal as they assist with the ability and conducting a study (Creswell, 2013). Assumptions are beliefs in the proposed research and are necessary to conduct the research. It is assumed that procedural rules are followed and, if there is a problem within the system, errors will be reported. According to the American Nurses Association of Ethics for Nurses, nurses have an ethical duty to report medical errors, which include medication errors (Westrick & Jacob, 2016). However, studies have demonstrated medication errors are underreported (Bowdle et al., 2018) for fear of negative consequences such as termination of employment or disciplinary actions by the state board of nursing (Ghazal, Saleem, & Amlani, 2014).

Medication errors can be the result of treatment inconsistencies within the team caring for the patient or the functionality of the facility system used for documentation (Ghazal et al., 2014). Even though a medication error may not be the fault of the nurse, many errors are not reported by the nurse (Bowdle et al., 2018). The fear of negative exposure has deterred nurses from disclosing medication errors (Bowdle et al., 2018), which may skew medication error reporting for this study. Based on this finding, I have completed individual chart reviews to determine whether medication errors had occurred and were not reported by calling the patient safety hotline or using the JPSR system.

Scope and Delimitations

The purpose of this study was to investigate the comparison between using an electronic nursing note or BCMA software to document medication administered within the ED and subsequent medication error rates. This study has measured and compared the

rate of medication errors that occurred while documenting medication administration within an electronic nursing note located within CPRS compared to the rate of medication errors that occurred while documenting medication administration using BCMA software within a VA Medical Center located in the Southeastern United States. A delimitation of this study is that data were collected within one hospital. Therefore, data comparison could not be identified between more than one hospital which limits the population identified. Another delimitation is the CPRS which is VA specific, utilized only at VA Medical Centers throughout the nation.

EHR systems vary among facilities and many combined patient order entry systems and medication administration systems into one software technology. Providers at the Veterans Health Administration use three different software technologies during the medication process. First, a designated provider enters medication order(s) within the CPRS software system. Then, a pharmacist verifies medication orders within the VistA system. Finally, the nurse verifies the medication order within CPRS and documents medication administration by using the BCMA software system. The use of these three systems (CPRS, VistA, and BCMA) are part of the infrastructure, within the VA Medical Center, that supports clinical care.

Limitations

For a study to be valid, the data must be reliable (Kaplan & Saccuzzo, 2005). Therefore, the accuracy of provider documentation within the EHR is essential for investigative research studies (Kaplan & Saccuzzo, 2005). Mistakes can happen, and EHRs may contain incorrect information that could skew the data collected (Kaplan &

Saccuzzo, 2005). Research has demonstrated that self-reporting medication errors are likely underreported (Etchegaray & Throckmorton, n.d.; Rishoei, Hallas, Kjeldsen, Christesen, & Almarsdottir, 2017) which could alter the collection of medication errors reported through the patient safety hotline and the JPSR system. No medication errors were reported through the patient safety hotline or JPSR system during the investigative periods of this study.

This study was conducted at a VA Medical Center located in the Southeastern United States. Therefore, the transferability of results to another location within the United States or other countries may decrease the chance of making the information generalizable to other populations. First, the stabilization period for implementing new technology may fluctuate from one hospital setting to the next (Gibson, 2013). This may increase or decrease exposure to consultant knowledge. Second, nursing staff may have various levels of technological knowledge and experience using technology. More experienced nurses will be quick to learn and conform to the process while others may feel uncomfortable with technology and work around the system. Third, data may be conducted during times of environmental variation. The ED is not always chaotic, but when it is, it can be emotionally, physically, and mentally draining (Di Simone et al., 2018). In times of chaos, a provider may choose to use a workaround because they do not have the time needed to follow the correct documentation process. Bypassing a technology solution for medication administration leads to increased medication errors (Bridgeman & Rynn, 2008; Hummel et al., 2010). The data collected could represent a time period of chaos or calm conditions in the ED.

Significance of Study

The implications of this study included filling a gap by examining medication error rates while not using BCMA in the ED, medication error rates while using BCMA in the ED, and work-related influences that may contribute to why medication error(s) occur.

Medication Error Rates not using BCMA within the ED for Inner Facility Patient Transfers

Safe patient care has long been the focus of social change throughout the United States (Kohn et al., 2000). This study will contribute to information that may improve our standards of care regarding technology as a means of documenting medication administration. Many facilities have not implemented BCMA technology in their ED (Glover, 2013). Lack of consistency within the EHR creates an interruption within the patient's record of care. Without continuity within the patient EHR, there may be a greater possibility that medication errors will occur for the patient transferred from the ED to an inpatient unit.

Medication Error Rates while using BCMA within the ED for Inner Facility Patient Transfers

Research demonstrates inpatient units within hospitals that use BCMA to document medication administered to patients have drastically reduced medication errors (DaSilva & Krishnamurthy, 2016; Glover, 2013; Kelly et al., 2016; Radwin et al., 2016; Shaw et al., 2016; Staggers et al., 2015). This research will fill a gap focusing on the medication error rates related to BCMA technology use within the ED for patients

transferred to inpatient units of the hospital. This project is unique because it addresses an under-researched area related to BCMA software technology used in the ED (Glover, 2013). This study has helped to discover whether the use of BCMA has mitigated medication errors for patients transferred from ED to inpatient units by using BCMA in the fast-paced ED environment.

Significance for Positive Social Change

The potential units for positive social change include assuring that patients do not experience medication errors that could cause significant morbidity or even death. When medication errors occur, it increases the burden on family and friends because the patient requires more care, sometimes for the rest of their lives. For the health care organization, the cost of litigation can be staggering. This outcome results in resources (human, financial, etc.) being drawn away from other operational units in the organization. Nurses involved in an error situation may experience frustration and sorrow for the patient. They could be investigated and have their license sanctioned. If the harm to the patient is severe, the nurse can experience guilt for the remainder of their career. As a community institution, healthcare overall is impacted by medication errors because it fosters distrust and a culture of suspicion by patients, staff, and other stakeholders.

Summary

BCMA is a software technology that is integrated within the EHR. Using BCMA software allows the nurse to electronically validate the medication provided to the patient is correct. This method has been proven to decrease medication errors within the inpatient units of the hospital and long-term care facilities (DaSilva & Krishnamurthy, 2016;

Glover, 2013; Kelly et al., 2016; Radwin et al., 2016; Shaw et al., 2016; Staggers et al., 2015). However, many hospitals have not implemented BCMA technology in their ED (Glover, 2013).

Prior to implementing the use of BCMA software technology into the ED, the ED nurse documented medication administered in the ED within an electronic nursing note. This note was located within the CPRS. The electronic nursing note has no required field to document the five rights of medication administration. Inaccurate and/or incomplete medication lists may lead to an omission or duplication of ordered medication (Hummel et al., 2010). Standardizing the medication administration documentation process, by using BCMA technology within the ED, may result in a more consistent EHR. However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). Additional research is needed to investigate whether standardizing the documentation process of medication administration by using an electronic medication administration record (such as BCMA software) to streamline use between inpatient and ED increases patient safety by decreasing the number of medication errors occurring in hospitals (Pevnick et al., 2018).

Medication errors uncovered by reviewing patient records were analyzed to answer the research question: For patients ordered to have medications administered in the ED prior to transferring to an inpatient unit, does documenting medications given using BCMA technology as compared to an electronic nursing note reduce medication errors. A quantitative nonexperimental descriptive comparison research design was used to assess medication error rates for patients that were ordered to receive medications in

the ED and transferred from the ED to an inpatient unit both before and after the implementation of BCMA technology in the ED. Quantitative research designs are often used to investigate causal relationships but may also be used to investigate relationships between variables (Gray et al., 2017). The study conducted is a descriptive design because the data has not been manipulated, and no interventions or treatments were made to the information obtained. Descriptive designs are considered nonexperimental. A comparison was made to examine the relationship between the DV, medication error, and the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit. After data was collected, I used Chi-square statistics to identify the difference between the DV and IVs.

Chapter 2: Literature Review

Introduction

Medication errors can occur during all phases of patient care (Medicacao, 2015; Vilena, & Jerico, 2015). The most susceptible units for medication errors tend to be high demand units that provide care to patients with more complex and severe diagnoses such as the ED (Medicacao, 2015). Since the publication of the Institute of Medicine report, *To Err Is Human*, health systems that have adopted technology and information systems to improve the medication delivery process have reduced medication error rates by 40% to 70% for hospitalized patients (Shaw et al., 2016). According to DaSilva and Krishnamurthy (2016), the ED is the third most common hospital unit that medication errors occur. The complexity of medications administered in the ED only exacerbates the significant need for the implementation of BCMA software technology within this unit of patient care (Bonkowski et al., 2013). However, most ED medication orders are written to be administered now, stat, on call, or one time as compared to scheduled medication orders placed within inpatient units. Therefore, using BCMA to document medications administered within the ED may triple the steps of the emergency room nurse compared to medical-surgical nurse using the identical software (Vilena & Jerico, 2015).

BCMA software can be integrated into the hospital's EHR system. In BCMA, when the nurse scans the patient's wristband, the patient's electronic medication administration record will populate within the BCMA software system. Next, the nurse will identify the patient by using two patient-specific identifiers (such as full name, full date of birth or full social security number) and verify what the patient has stated matches

what is displayed within the BCMA software technology system. After reviewing the medication due list displayed in BCMA, the nurse will scan the medication(s), look at the BCMA screen, view whether the medication was marked as given and continue to scan the next medication. Finally, the nurse will assure the patient ingests the scanned medication. If the scanned medication does not match the ordered medication, a 'do not give' warning message will populate in BCMA alerting the nurse that the medication scanned is not correct. When this occurs, the nurse will follow facility policy to assure the correct medication for the patient is administered and documented as given.

The use of BCMA has been demonstrated to decrease medication errors within hospitals and long-term care facilities (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA software technology in their ED (Glover, 2013). Lack of continuity within the EHR may pose a greater risk for medication errors to occur for patients that have had medication ordered to be administered within the ED and have transferred from the ED to an inpatient unit (Glover, 2013).

According to Kohn et al. (2000), approximately 98,000 hospital deaths were caused by avoidable medical errors within the United States healthcare system. As medical error publications emerged, society demanded that providers make improvements in the healthcare system (Ford, McAlearney, Philips, Menachemi, & Rudolph, 2008). The call for the transformation of healthcare was addressed by President George W. Bush in 2004 when he introduced the health information technology plan and

established the National Coordinator for Health Information Technology with the duty of national implementation of EHR by the year 2014 (Ford et al., 2008).

The purpose of this study was to investigate the comparison between using an electronic nursing note or BCMA software technology to document medication(s) administered within the ED and subsequent medication error rates. This study investigated medication error rates that occurred while documenting medication administration within an electronic nursing note located within the CPRS compared to medication error rates that occurred while documenting medication administration using BCMA software technology within a VA Medical Center located in the Southeastern United States. To address this gap, I conducted a quantitative nonexperimental descriptive comparison research study to examine the comparison between medication error rates when an electronic nursing note is used to document medication(s) given compared to using BCMA software to document medication(s) given to patients who were ordered to receive medication(s) in the ED before transferring to an inpatient unit within the VA Medical Center where this study took place.

Relevance of Problem

The ability to administer medication safely and effectively remains a high priority for healthcare facilities. BCMA software has been developed and is being used by hospitals and long-term care facilities to aid in this process. The VA Medical Center uses BCMA software technology. It is integrated software used within the EHR. This method has been proven to decrease medication errors within the inpatient units of the hospital and long-term care facilities (DaSilva & Krishnamurthy, 2016; Glover, 2013; Kelly et al.,

2016; Radwin et al., 2016; Shaw et al., 2016; Staggers et al., 2015). Using BCMA software technology allows the nurse to electronically validate the medication(s) provided to their patient is correct.

In this chapter, I provide a summary of literary search strategies, the theoretical foundation, and the conceptual framework of this study. Afterward, I will provide a literature review related to the research. This literature review includes an exploration of what is known about the use of BCMA technology within the inpatient and outpatient hospital units, various workarounds used by staff members during medication administration, the patient transition of care and medication errors.

Literature Search Strategy

Articles included within this review were accessed through PubMed, Medline, Google Scholar, and Walden University library with the use of following single text words and combinations: *Barcode Medication Administration, bcma, bcma use in the emergency department, bcma use in an emergency room, bcma in hospital, medication management, medication errors, medication emergency room, medication emergency department, medication patient transfer, medication errors patient transfer, medication error reporting, errors transition of care, errors continuity of care, transition of care, and continuity of care,* and *transitional care model.* Sources of literature search included peer-reviewed journals, published books and reports, VA handbooks, published dissertations, pharmaceutical journals, informatics journals, technological journals, and nursing education journals. To keep current, a focus was placed on reviewing literature

that was published within the past 5 years. However, seminal literature reviewed may be sited to outline medication reviews within a historical perspective.

Many studies have demonstrated that documenting medication administration by using BCMA software technology helps prevent medication errors (Seibert et al., 2014), however, there is little research that identifies the use of BCMA software within an ED relating to medication errors. Within the literature search, I have provided an investigative outline of the benefits and drawbacks of using BCMA software technology within the ED setting. I have also investigated BCMA software technology use within the ED and potential workarounds that may have occurred as a result of the documentation process of medication administration within the fast-paced ED environment.

Theoretical Foundation

Successfully transferring patient information from an outpatient setting to an inpatient setting while sustaining the highest quality care involves teamwork from all disciplines caring for the patient (Naylor & Berlinger, 2016). Studies have demonstrated that medical errors have decreased when providers effectively communicate patient information from one level of care to the next (Kennelty et al., 2016). Therefore, healthcare organizations must ensure that patients are not exposed to risks such as communication errors as the patient transfers to the next care setting (Mueller et al., 2018; Naylor & Berlinger, 2016). This professional team helps provide safe and timely transfer of care while controlling financial and emotional costs (Naylor & Keating, 2008).

Most often the reason a patient is transferred from one care setting to another is that their medical care needs have changed to a greater or lesser monitoring status

(Bowdle et al., 2018; Cacchione, 2016; DelBoccio, 2015; Naylor, 2000; Naylor & Keating, 2008; Rezapour-Nasrabad, 2018). Transitional care is a recognized evidence-based approach for improving care provided during patients transitioning between care settings (Hirschman et al., 2015; Naylor, 2000; Rezapour-Nasrabad, 2018). Transitional Care Theory is used to increase outcomes for patients who transfer from one care setting to another (Hirschman et al., 2015).

The theoretical base for this study is Transitional Care Theory, specifically the Transitional Care Model. This model targets the older adult population and the CoC delivered by various disciplines throughout the patient's hospital stay (Hirschman et al., 2015). The Transitional Care Model was created and developed by Dr. Mary D. Naylor, ~~w~~ith the assistance of a multidisciplinary team at the University of Pennsylvania School of Nursing (Cacchione, 2016). Originally the Transitional Care Model was used for cardiac patients, however, after diligent study, Dr. Naylor enforced the need for use with patients who have been diagnosed with multiple chronic conditions (Cacchione, 2016; Naylor & Keating, 2008). Hospital studies have demonstrated that the quality of patient care and patient outcomes improved, and patient care costs decreased after the hospital had implemented the use of the Transitional Care Model within their care facility (Cacchione, 2016).

Transferring a patient has proven to be a complicated process involving two separate units (Cacchione, 2016; Kulshrestha & Singh, 2016; Naylor, 2000). Both care settings must communicate with one another and provide proper documentation and handoff to ensure a safe patient transfer (Kulshrestha & Singh, 2016). Transitional care

emphasizes continuity, coordination, relationships, engagement, collaboration, and education (Cacchione, 2016). The Transitional Care Model incorporates each component within the patient transfer process. Without these communication components, patient care would suffer, and errors would be more likely to occur (Cacchione, 2016; Naylor, 2000).

According to Kulshrestha and Singh (2016), transfer documentation is the most important part of the patient transfer process. However, transfer documentation is often overlooked because of hastily organized patient transfers. Kulshrestha and Singh (2016) suggest that a standardized document should accompany every patient transfer to include the patient's full name and condition, the reason for the transfer, names of referring and receiving providers, vital signs, clinical events and treatments given. Along with the documentation, Kulshrestha and Singh (2016) suggest a face to face communication should be verbalized by the transferring team to the receiving team of providers. Hammond (2015) concluded that providers should consider patient care as ‘continuum’ status instead of ‘inpatient’ and ‘outpatient’ status exclaiming, in this way, providers could then anticipate the patient needs as they move through that continuum instead of discharging from one status only to admit them into another.

Noncollaboration among healthcare providers has been recognized as a serious problem associated with negative outcomes among hospitalized patients that transition from one healthcare setting to another (Hirschman et al., 2015). Thirteen to twenty percent of preventable older adult rehospitalizations have been associated with limited follow-up, poor CoC, and gaps in services as patients move between healthcare providers

and across care settings (Hirschman et al., 2015). Transitional Care Theory is designed to help prevent communication breakdown between healthcare providers (Naylor, 2000). Supporting Transitional Care Theory with the use of health information technology (such as EHRs) may help prevent gaps in inpatient care services, increase care quality and improve patient outcomes (Hirschman et al., 2015).

When a provider uses BCMA software technology to document medication administration within the patient EHR, another provider can immediately identify medications that have been administered to a patient (DaSilva & Krishnamurthy, 2016; Radwin et al., 2016). When the provider uses an electronic nursing note to document medication administration within the EHR, another provider must look within an electronic nursing note within the EHR to identify medications that were administered to the patient (Staggers et al., 2015). This form of medication review may take several minutes which may delay treatment (Staggers et al., 2015).

Nurses have been known to miss documenting medications administered to their patients (Di Simone et al., 2018). If the nurse in the unit that receives the patient does not see that medication was given by the previous nurse, there is a possibility that the patient may be given a second dose of the already administered medication. This insufficient documentation method puts the patient at risk. By documenting medication administered within the BCMA software system, the receiving nurse has access to immediately view all medications administered by the previous nurse (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA technology in their

ED (Glover, 2013). Without continuity within the patient EHR, there may be a greater possibility that medication errors will occur for the patient transferred from the ED to an inpatient unit.

Conceptual Framework

During the past decade, patients are spending less time in hospitals, have a greater number of healthcare disciplines managing their care, and expect more from hospitals coordinating their care (Minvielle et al., 2010). To obtain and sustain high-quality medical care, there must be a method of communicating patient information from one healthcare professional to another. When healthcare providers use the CoC concept, they practice a communication strategy necessary to coordinate patient care that could result in a less fragmented exchange of information (Minvielle et al., 2010). This CoC technique may provide a means to improve patient safety and increase the quality of patient care.

This study refers to the CoC and how it is related to the patient care experience over the course of their healthcare-related experiences. According to Reid et al. (2002), CoC measures consists of the chronologic order of a patient's contact with healthcare providers. In 2002, a conference was held for the Canadian Health Services Research Foundation, the Canadian Institute for Health Information, and the Advisory Committee on Health Services of the Federal/Provincial/Territorial Deputy Ministers of Health, CoC was recognized for concepts which included the duration and frequency of patient and provider contact, how informed providers are in regards to the multiple providers caring for the patient, and the extend of care completed from one provider to the next.

The most common method for measuring the transfer of patient information from one provider to the next is to examine whether this health-related information is recorded and communicated between providers (Reid et al., 2002). This type of measure is most used when a patient is moved from one level of care to another. However, multiple studies have found that poorly managed health records are the leading cause that often results in low-quality patient outcomes and human and economic suffering (Hirschman et al., 2015). A contributing factor to poorly managed patient care is that patient information is often conveyed directly from one provider to the next (Pereira et al., 2005) rather than documenting within the patient chart. This type of information exchange may lead to medication errors.

CoC Components

A high standard of multidisciplinary support is needed to obtain the best outcome while coordinating care for the transfer of a patient from one unit of a hospital to another. The Transitional Care Model involves participation from the healthcare team involved in this coordination of care (Shiou-Liang & Hubertus, 2015). Kohnke and Zielinski (2017) have defined CoC as a growing relationship between the patient and healthcare provider(s); whereas they both assume the responsibility of care coordination which results in the quality of care. The three components of CoC are informational, relational , and management continuity (see Figure 1).

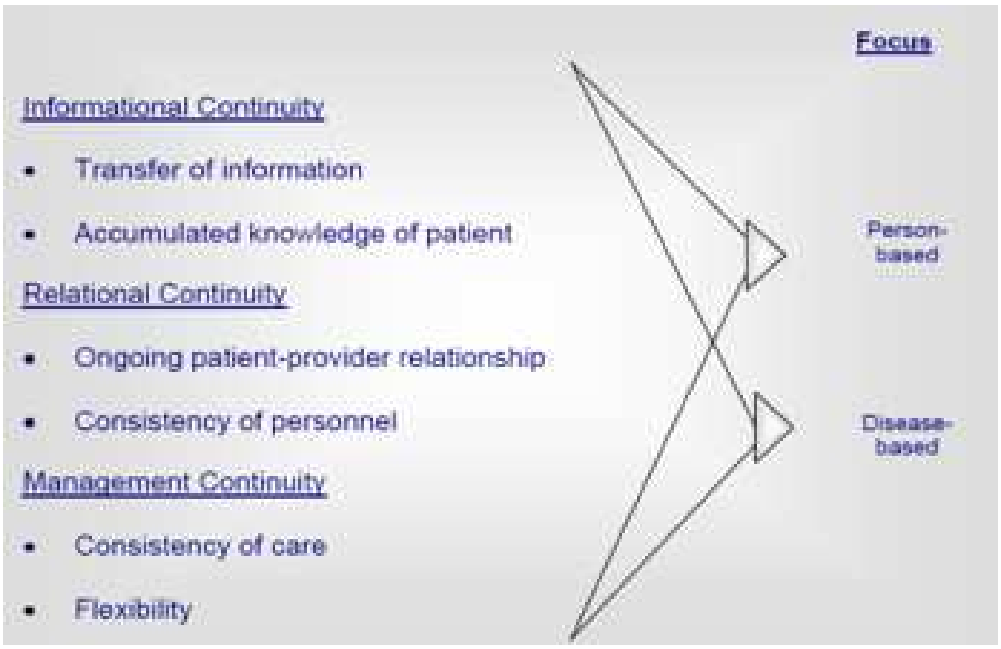

Figure 1. Types of Continuity. Defusing the confusion: concepts and measures of continuity of healthcare Canada: Canadian health services research foundation. Reid, R., Haggerty, J., & McKendry, R. (2002). The Canadian Institute for Health Information, and The Advisory Committee on Health Services of the Federal/Provincial/Territorial Deputy Ministers of Health.

Informational continuity embraces the communication component when transferring patient information. This transfer involves active communication between the patient and provider as well as other providers. This accumulated knowledge of patient information is an essential component of CoC. Relational continuity consists of an ongoing patient-provider relationship whereas the 'relationship' grows to encompass a holistic aspect of care. Relational continuity can also be defined as the 'relationship' between provider to provider. The ability to have consistency with providers caring for patients is a key factor in relational continuity, although this may not be possible in today's healthcare (Kohnke & Zielinski, 2017). Technology is thought to be another aspect of relational continuity because technological devices can communicate among

other devices. Communication through technology is a type of continuity which can also be defined as interoperability (Voltz, 2015). The Office of the National Coordinator for Health Information Technology has defined four domains of interoperability. These domains include finding, sending, receiving, and integrating patient health information from outside sources (Holmgren, Patel, Charles, & Adler-Milstein, 2016). If one domain is not functional, relational continuity may cease.

Finally, the third type of continuity is management continuity which relates to the consistency of care and flexibility. Patients with chronic and complex diagnoses are, generally, seen by several providers. These providers must coordinate patient care efforts to provide more consistent care for optimal outcomes (Haggerty et al., 2002). Management continuity refers to flexibility in patient care which is also considered consistent (Haggerty et al., 2002). Consistency in care within the healthcare profession has many positive attributes relating to positive patient outcomes (Kohnke & Zielinski, 2017). Flexibility relates to the adaption of patient care as their needs change. For example, continuity of contact may be more prevalent for a patient with a recent mental health diagnosis which may require higher than average provider contact. Over time, this same patient needs may change, resulting in less frequent provider contact.

Each of the antecedents compliments the next. Informational continuity aids with Transitional care through patient and provider communicating and sharing information in a meaningful way (Reid et al., 2002). Relational continuity contributes to the patient and providers shared information forming a relationship between participants (Reid et al., 2002). Finally, management continuity provides a structure for the preceding antecedents

(Reid et al., 2002). Shared information, consistent communication, and flexible plans are essential components to help provide long-lasting high-quality patient care.

CoC Research

Saultz and Lochner (2005) reviewed 40 CoC research studies that focused on patient and family health outcomes. There was a significant positive association in 35 studies and only two studies reported a negative association for the use of longitudinal CoC in healthcare and improved patient outcomes. A three-year study conducted by Kohnke and Zielinskib, (2017), indicated a higher longitudinal CoC to be associated with fewer ED visits. These higher CoC has also been shown to be associated with a reduced number of ED visits in specific population groups, such as elderly and patients with specific chronic illnesses such as chronic obstructive pulmonary disease and heart failure (Kohnke & Zielinskib, 2017). The Usual Provider of Care index (UPC), Continuity of Care Index (CoCI), and Sequential Continuity index (SECON) tools were used to quantify CoC within the study. Each tool resulted in positive distribution which indicates a higher longitudinal CoC. The median for UPC, CoCI, and SECON were 0.33, 0.18, and 0.33 respectively. Longitudinal CoC was shown to decrease the amount of ED visits therefore, these studies were significant and clinically relevant.

Benefits of CoC

To provide high-quality patient care a provider must allow enough time to be able to review previous orders, lab work, past medical history, etc. A provider may be able to provide patient care more expeditiously if the provider could view previously administered medications immediately within the EHR. This could be possible if BCMA

software technology was used to document medication administered to the patient. On the other hand, it could take a considerable amount of time for the provider to locate what medication may have been administered if the nurse documented within an electronic nursing note. This study will benefit from the use of the CoC concept by identifying whether a difference exists between medication documentation using BCMA software technology compared to an electronic nursing note and if these documentation practices had a positive or negative effect on patient outcomes.

Literature Review

Theory

Transitional Care Theory is designed to help prevent communication breakdown between healthcare providers (Naylor, 2000). The National Institute of Nursing Research (NINR) conducted a randomized clinical trial (RCT) that demonstrated that patients who received Transitional Care Model were less likely to be hospitalized ($p=0.026$) than those that did not (Hirschman et al., 2015). Fewer rehospitalizations (104 vs. 162, $p=0.047$) were observed which contributed to an annual per-patient savings of $4,845 ($p=0.002$; (Hirschman et al., 2015). The study concluded Transitional care improved patient care experiences as well as the quality of life outcomes, reduced rehospitalizations and decreased total healthcare costs. Transitional Care Theory along with the use of health information technology may help prevent gaps in inpatient care services, increase care quality and improve patient outcomes (Hirschman et al., 2015).

According to Bayliss et al., (2015), consistent documentation within an integrated delivery system (such as an EHR) has been proven to be an essential component of CoC.

Inconsistent informational continuity has been proven to generate higher rates of negative patient outcomes (Bayliss et al., 2015). A retrospective cohort study that included 12,200 seniors with three or more chronic conditions within an integrated delivery system demonstrated higher CoC, respective hazard $r = 0.97$ [0.96, 0.98] and 0.98 [0.96, 1.00], were associated with a lower risk of ED visits (Bayliss et al., 2015). The use of documenting information using an EHR system enables patient care providers immediate access to patient information.

Medication Errors

A retrospective study of reported medication errors in the ED conducted by Cabilan, Hughes, and Shannon (2017) discovered most medication errors occurred during medication administration ($n = 254$) 62.7%, prescribing ($n = 41$) 10.1% and when prescribing led to administration errors both stages ($n = 75$) 18.5%. Prescribing errors ($n = 41$) included wrong dose 31.7%, wrong medication 14.6%, wrong patient 14.6%, omission 12.2% and documentation error 7.3%. During the medication administration process ($n = 254$), wrong dose 27.2%, omission 23.2%, wrong medication 13.4%, administered but not signed 7.1% and wrong times 6.3% were the five most frequently occurring issues. For errors that occurred at prescribing and administration ($n = 75$), wrong dose 35.1%, wrong medication 25.7% and giving medications despite known allergy 16.2% were the most common occurrences. This study concluded medication errors in the ED most frequently occurred in the prescribing and administration phases. Incomplete patient assessments and/or underutilizing reference materials contributed to the prescribing phase errors. Five right verification, independent double verification, and

disruptions during the medication administration process were cotributing factors to medication error occurrences during the administration phase.

The Institute of Medicine has estimated that each hospitalized patient is apt to experience one medication administration error per day, and errors are less likely to be intercepted at the administration phase of the medication process (Koppel, Wetterneck, Telles, & Karsh, 2008). Nursing service is primarily responsible for medication administration within a hospital environment. Therefore, the act of administering medications to hospitalized patients is a critical component of the nursing process. The nurse must use diligence when verifying the right patient is getting the correct drug, the right dose and route has been provided and that it is being administered at the right time (Grissinger, 2010). Documenting medication administration by using BCMA software technology has been proven to decrease medication errors within the inpatient units of the hospital and long-term care facilities (DaSilva & Krishnamurthy, 2016; Glover, 2013; Kelly et al., 2016; Radwin et al., 2016; Shaw et al., 2016; Staggers et al., 2015).

Inpatient Before/After BCMA Software Utilization

In an often-cited classic study of 14,041 observations of medication administrations, BCMA was reported to reduce medication errors by 41.4% (Poon et al., 2010). In a more recent study, Thompson et al., (2018) addressed medication errors before and after BCMA implementation within an inpatient setting. The study was conducted from March 1, 2007, through September 30, 2013, and included only medication errors that had occurred; no potential medication errors were included in this study. The study determined that the use of BCMA technology decreased the medication

error rate by 43.5%. Also, the rate of medication errors that resulted in patient harm decreased from 0.65 per 100,000 medications before BCMA implementation to 0.29 per 100,000 medications after BCMA implementation. Overall, this facility incurred a 55.4% reduction in actual patient harm using BCMA technology for the administration of medication.

ED Before/After BCMA software Utilization

An observational study was conducted by Bonkowski et al., (2013) at an academic medical center before and after BCMA was implemented in the ED. A total of 996 pre-BCMA and 982 post-BCMA medication administrations were observed within this ED. Before using BCMA software technology to document medication administration within the medical centers ED, medication administration error rates accounted for 6.3% of the total medication doses (996) given. An incorrectly administered dose accounted for 66.7% of the total error rate. After the implementation of BCMA software technology, this medical center ED witnessed a reduction of 80.7% ($p < 0.0001$) in medication administration error rate, wrong dose errors decreased by 90.3% ($p < 0.0001$), and medication administrations with no physician order decreased by 72.4% ($p = 0.057$). The study concluded health facilities that are contemplating the use of electronically documenting administered medications should consider the implementation of a BCMA software technology within the ED.

Pharmacy Verification

Pharmacy verification is a mandatory step before administering medication to the patient within units that use BCMA software technology (Staggers et al., 2015). A

pharmacist is tasked with the verification process to accurately reflect a patient's medication history, clarify medications and dosages are appropriate and document medication changes to assure all medications taken by the patient are compatible (McNew, 2014). After the pharmacist has completed these steps, the medication will populate within the BCMA software system. Therefore, pharmacist availability is an essential component for the implementation of BCMA software technology. A national survey reported that in the year 2006 only 3.4% of hospitals employed a pharmacist within their ED environment (Thomas, Acquisto, Shirk, & Patanwala, 2016). The number increased to 6.8% in 2008 and 16.4% in 2014 (Thomas et al., 2016). These statistics accentuate the importance of an ED pharmacist presence when BCMA software technology is used in the ED.

A study reviewed by Barra, Culbreth, Sylvester, and Rocchio, (2018), determined the rate of medication errors within the ED declined by over two-thirds after a pharmacist review was implemented. And, when the pharmacist recommended another drug therapy other than what the provider prescribed, the recommendation was accepted 99% of the time. Another study found that a pharmacy verification process derailed potential medication errors in 7.8 per 100 patients. ED patients comprised 6.8% of the potential medication error interceptions; 52.4% had the potential to cause serious harm and 36.2% had the potential to cause significant harm to the patient.

Emergency Department

Medication administration represents 40% of a nurse's clinical activity and a nurse is the last safety measure before medication administration (Di Simone et al., (2018).

Therefore, the nurse must take precautions to ensure the correct medication is given to the patient. EDs are often overcrowded and consist of patients that need immediate attention. A study conducted by Di Simone et al., (2018) concluded that approximately 85% of medication errors that occurred within the ED were caused by disruptions while the nurse is in the medication administration process. This study did not identify medication charting procedures. When BCMA software technology is used and the medication the nurse is attempting to scan was not the medication identified within the patients electronic medication administration record, a warning box will populate, display the medication is not found, and the nurse would have to acknowledge the warning box before proceeding to do anything more within the EHR. When a nurse charts medication administration within an electronic nursing note and the medication the nurse was giving is not the medication identified within the patient's medication order list, the CPRS would not produce a warning and the wrong medication could be administered to the patient.

BCMA Compliance

According to Staggers et al., (2015), documenting medication administration by using BCMA software technology has been proven to reduce medication errors. However, nurses have voiced concern stating that using BCMA software technology to document medication administration has disrupted workflow. Ninety-nine BCMA software usability problems were identified of which, approximately 80% involved three individual BCMA software tasks which included administering and charting medications (n = 38) 38.4%, congruence with known screen design principles (n = 27) 27.3% and preparing medications (n = 14) 14.1%. This study concluded that improvements need to

be made to decrease the time-consuming task of charting medication administration within the BCMA software system.

Most medication orders within the inpatient units of a hospital are to be administered at scheduled times which mainly consist of once, twice, and three times daily dosing (Staggers et al., 2015). However, medications within the ED environment comprise of less than routine schedules. ED medications are often ordered to be given now, stat, on call or one time (Cabilan et al., 2017). Emergent patient care signifies the need for an ED nurse to encounter more workload fluctuations, interruptions, and distractions (Cabilan et al., 2017). ED nurses are tasked with administering medications timely and effectively without compromising patient safety (Staggers et al., 2015). ED providers have reported that the use of BCMA software technology has increased the amount of time it takes to administer medications; therefore, workarounds have been created which may compromise patient safety (Staggers et al., 2015).

Summary

One of the leading causes of serious harm is fragmented care related to medication administration errors (Stewart et al., 2015). The use of BCMA software technology allows the nurse to enter medication administration within the patient's EHR. By doing so, other providers can view medications administered in real-time (immediately after administration). According to the Institute of Medicine (2008), medication errors have decreased since the adoption and use of BCMA software technology within healthcare settings. The continuity of recording medication documentation between care units may improve the transition of care. By implementing a

system to create and sustain CoC throughout the patient care continuum, the facility may have the means to deliver higher quality care and increase the potential for positive patient outcomes.

BCMA software technology has been proven to decrease medication errors within hospitals inpatient units (DaSilva & Krishnamurthy, 2016; Glover, 2013; Kelly et al., 2016; Radwin et al., 2016; Shaw et al., 2016; Staggers et al., 2015). Health systems that have adopted BCMA software technology have reduced medication error rates within their facility by 40% to 70% for hospitalized patients (Shaw et al., 2016). However, little research has been completed regarding medication error rates and BCMA software technology used for documenting medication administration within hospital EDs (Glover, 2013; Hummel et al., 2010; Pevnick et al., 2018). And, according to Glover (2013), there has been a limited amount of hospital s EDs that have implemented BCMA software technology within this environment. This lack of consistency within the EHR creates an interruption within the patient's record of care. Without continuity within the patient EHR, there may be a greater possibility that medication errors will occur for the patient transferred from the ED to an inpatient unit.

According to DaSilva and Krishnamurthy (2016), the ED is the third most common hospital unit that medication errors occur. The complexity of medications administered in the ED only exacerbates the significant need for the implementation of BCMA within this unit of patient care (Bonkowski et al., 2013). Research completed by Shaw et al. (2016), identify the potential for improving the compliance rate of patient identification before medication administration increased with the use of BCMA software

technology. Therefore, implementing the use of BCMA within the facility ED may provide a safer way to document medication administration which may result in improved patient safety.

Conclusion

A consistent means of medication documentation must be created to ensure the next care setting has accurate patient information. The use of BCMA software technology has been associated with continuity within the patient's EHR. However, studies have demonstrated BCMA software use in the ED setting as a challenge because the nursing staff was identified as performing unsafe workarounds to process patients through their unit quickly (Glover, 2013; Vilena & Jerico, 2015). This study has investigated the occurrence of medication errors before BCMA software technology was implemented within the ED and after BCMA software technology implementation within the ED at a VA Medical Center located in the Southeastern United States.

The purpose of this study was to investigate the comparison between using an electronic nursing note or BCMA software to document medication administered within the ED and subsequent medication error rates. This study has measured medication error rates that occurred while documenting medication administration within an electronic nursing note located within the CPRS compared to medication error rates that occurred while documenting medication administration using BCMA software within the VA Medical Center where this study took place.

To address this gap, a quantitative nonexperimental descriptive comparison research design was used by completing retrospective chart reviews before and after the

implementation of BCMA software technology in the ED at the VA Medical Center located in Southeastern United States. Quantitative research designs are often used to investigate causal relationships but may also be used to investigate relationships between variables (Gray et al., 2017). The study conducted is a descriptive design because the data will not be manipulated, and no interventions or treatments will be made to the information obtained.

Descriptive designs are considered nonexperimental. A comparison was made to examine the relationship between the DV, medication error, and the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit. After data was collected, I used Chi-square statistics to identify the difference between the DV and IVs. Therefore, I have conducted a quantitative nonexperimental comparative descriptive research design using Chi-square statistics to identify whether documenting medication(s) administered by using BCMA software technology in the ED mitigates medication errors for patients that were prescribed medication(s) to be given in the ED before transferring to an inpatient unit within the VA Medical Center where this study took place.

This retrospective study using secondary data has identified if a relationship exists between the DV, medication error, and the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications

administered within the ED prior to patient transfer to an inpatient unit. The methodology used in this quantitative case study design will be discussed in the following chapter.

Chapter 3: Research Method

Introduction

Within this study, I investigated whether medication errors decrease when documenting medication administration within an electronic nursing note is replaced by documenting medication administration by using BCMA technology for patients that have been given medication(s) in the ED then transferred to an inpatient care unit. The use of BCMA has been demonstrated to decrease medication errors within hospitals and long-term care facilities (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). The ED is ranked the third unit, within the United States hospital environment, that medication errors occur within the medication process (DaSilva & Krishnamurthy, 2016). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). I found limited literature addressing medical error rates for hospitalized patients transferred from the ED to inpatient units. This chapter includes research design and rationale. I explain participant selection, sampling, data collection, data analysis, and ethical concerns.

Research Design

BCMA software technology standardizes the medication administration process by requiring the provider to use the five rights of medication administration before administering medication to the patient. The creation of the electronic medication administration record provides continuity within the EHR. Without continuity within the patient EHR, there may be a greater possibility that medication errors will occur. Inaccurate or incomplete medication lists may lead to an omission or duplication of

ordered medications (Hummel et al., 2010). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013).

Medication errors can occur during all phases of patient care (Medicacao, 2015; Vilena, & Jerico, 2015). The most susceptible units for medication errors tend to be high demand units that provide care to patients with more complex and severe diagnoses such as the ED (Medicacao, 2015). According to DaSilva and Krishnamurthy (2016), the ED is ranked the third unit, within the U.S. hospital environment, that medication errors occur within the medication process. Therefore, it is vitally important that all patient care information is communicated when the patient is transferred to another unit for care.

BCMA software is part of the patient's EHR. The use of BCMA has been demonstrated to decrease medication errors within hospitals and long-term care facilities (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). Lack of continuity within the EHR may pose a greater risk for medication errors to occur for patients that have had medication ordered to be administered within the ED and have transferred from the ED to an inpatient unit (Glover, 2013). This study has investigated medication error rates for two time periods which include medication errors that occurred while documenting medication administration within an electronic nursing note located within CPRS compared to medication error rates that occurred while documenting medication administration using BCMA software.

BCMA software technology was implemented in the ED at this VA Medical Center in the Fall of 2017. I used SQL, a standard computer language that is used to manage and manipulate relational databases (Zentut, 2020), to conduct the patient record inquiry by extracting data from the CDW to include records of patients that were observed in the ED and ordered to receive medication in the ED before transferring to an inpatient unit.

Research Question

RQ1: What is the comparison in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit?

Time and Resource Constraints

BCMA software was implemented within the ED at this VA Medical Center in the Fall of 2017. This research allowed for stabilization, a period whereas the staff within the organization has been trained and has had time to adjust to the new way of doing a process or procedure (Longhurst et al., 2014). Therefore, I did not start to collect data for post-BCMA use until after the 6-week stabilization period was complete. This research would have included a review of medication errors reported through the patient safety hotline and JPSR system for patients who were ordered to receive medications in the ED and transferred from the ED to an inpatient ward. However, no medication errors were reported during the study pre-BCMA or post-BCMA data collection timeframe.

This case study has allowed the investigation of whether the use of BCMA software within the ED has had an impact on medication error rates compared to documenting medication administration within an electronic nursing note located within CPRS. By doing so, this study has contributed to the limited research that is known regarding the use of BCMA technology within this fast-paced environment (Glover, 2013). The information collected within this study may aid in determining whether the use of BCMA in the ED has had an impact on medication errors for patients that were prescribed medications to be given in the ED before transferring from the ED to an inpatient unit.

Methodology

Population Selection

In a quantitative research study, it is important to acquire information that can be duplicated as well as generalizable (Creswell, 2014; Leedy & Ormrod, 2001). A sample size estimation for proportion (Shuster, 1990) was used to estimate the number of patient records needed to obtain results reflecting the target population for this study. I used a confidence interval of 95% which suggests that there is a 95% probability that the interval contains the population parameter and that there is a 5.0% risk that the population parameter is not contained within the interval (Frankfort-Nachmias & Leon-Guerrero, 2015). A lower limit and an upper limit represent a range of values that denote the true population parameters with a specific level of confidence (Frankfort-Nachmias & Leon-Guerrero, 2015).

Binomial distribution (comparing proportions) of the denominator (number of medication orders) and numerator (number of errors) was conducted within the research study. Therefore, I have estimated the sample size of the study by proportional measures. For the study, I reviewed 129 patient records for patients that had medication(s) ordered to be administered within the ED before transferring to an inpatient unit both before and after BCMA software technology implementation.

BCMA software technology was implemented in the ED at the VA Medical Center where this study took place in the Fall of 2017. I used SQL to conduct the patient record inquiry by extracting data from the CDW to include records of patients that were observed in the ED and ordered to receive medication in the ED before transferring to an inpatient unit.

The ED at the VA Medical Center where this study took place operates jointly with the 152-bed inpatient tertiary care service that serves over 80,000 patients along the Southeastern coast of the United States. The facility is a level 1A facility and provides service to patients with the most complex level of care. The measurement used to conduct this study consisted of reviewing 129 patient records (minus medication errors reported through the patient safety hotline and joint patient safety records, if applicable) for patients that had medication(s) ordered to be administered within the ED before patient transfer to an inpatient unit during the specified period. I reviewed 129 patient records before BCMA was implemented in the ED and 129 patient records after BCMA was implemented in the ED for a total of 258 reviewed patient records.

Target Population

This study includes information collected from medication errors reported by calling the patient safety hotline, JPSR system and SQL queries of the CDW for patients seen in the ED, had medication order(s) to be administered in the ED and were transferred to an inpatient unit at the VA Medical Center where this study took place. Patients seen were those that served within our Military forces including Army, Navy, Air Force, Marines, and Coast Guard as well as their dependents if the related Veteran 100% service-connected and/or retired from the Military. This convenience sampling was conducted to collect patient data regardless of the patient's age, race or gender.

Sampling Procedure

Sampling includes data collection of a group of individuals with commonalities (Creswell, 2014). This study has identified patients observed in the ED that were ordered to receive medications in the ED before transferring to an inpatient unit. To attain this patient population, dates between the collected 1-129 patient records before BCMA was implemented in the ED at this facility in the Fall of 2017 were identified. If medication errors had been reported to the patient safety hotline or through a JPRS submission during this time, they would have been documented within the SPSS medication error data field. Medication errors of omission during this timeframe were recorded as medication errors within SPSS. Next, medications ordered to be administered in the ED before patient transfer within the VA Medical Center after the six-week post-BCMA time period, were obtained until a total of 129 patient records were collected. If medication errors had been reported within JPRS submissions during this time, they would have been

documented within the SPSS medication error data field. Medication errors of omission during this timeframe were also recorded as medication errors within SPSS.

Sampling Frame

The sample frame within a study consists of a group of individuals who have a legitimate chance of being selected (Creswell, 2014). Sampling throughout this study included patients that have obtained medical attention by entering the VA Medical Center ED, whose provider had ordered medications to be administered within the ED and was transferred to an inpatient unit. Generalizable ED medication administration data was collected before BCMA implementation in the Fall of 2107. The data includes 129 patient records for patients that had medication(s) ordered to be administered within the ED before the patient transferred to an inpatient unit. This data was required to conduct reviews of medication error rates before BCMA software implementation in the ED. Then, a six-week adjustment period (allowing for stabilization to occur after BCMA had been implemented) lapsed before collecting 129 patient records (for patients who had medication(s) ordered to be administered within the ED before patient transfer to an inpatient unit). This data was required to conduct reviews of medication error rates after BCMA software technology was implemented in the ED at the VA Medical Center where this study took place.

I am an employee of the VA Medical Center where this study was conducted. Therefore, I have access to reports submitted through the patient safety hotline, JPSR, CPRS, and the data depository for the VA Medical Center known as the CDW. The VA Medical Center research department and Health Equity Rural Outreach Innovation Center

(HEROIC) center provided me with a folder which is located on our firewall-protected VA Medical Center portal. This folder contains data collected throughout the study and is password protected which means access is only granted by those individuals with permission to open it. The three individuals with permission to access the folder are the director and chief nurse of the HEROIC program and myself.

This study used patient identifiable information from the patient records to collect data. However, no patient identifiable information will be shared in the study results. All collected data is electronically stored in a folder located on our firewall-protected VA Medical Center portal. This folder is password protected which means access is only granted by those individuals with permission to open it. The three individuals with permission to access the folder are the director and chief nurse of the HEROIC program and myself. After receiving the Medical University Institutional Review Board (IRB) notice of approval, VA Medical Center Research and Development (R&D) approval and Walden University Research Office approval, I began the SQL query only to realize the EDIS system would improve data collection efforts. Both systems extract from the CDW. Documentation exists on Excel spreadsheets, and SPSS. I maintained the strictest privacy to protect patient information.

Sample Size

Binomial distribution (comparing two proportions) of the denominator (number of medication orders) and numerator (number of errors) was conducted to determine the number of patient records needed for the research study. With significance level α=0.05, equal sample size from two proportions (r=1), the probability $p_1 = 0.33$ and $p_2 = 0.165$ are

considered sufficiently different to warrant rejecting the hypothesis of no difference. Then the required sample size for two arms to achieve an 80% power (β=0.2) can be determined by M=118, N=236.

The symbol P_1 and P_2 represents the proportions of event interest for each timeframe within the study. According to the American MEDMARX database, 33% of reported medication errors were associated with the medication administration phase prior to using BCMA software technology (Berdot et al., 2016). In previously cited studies (Poon et al., 2010; Thompson et al., 2018), the use of BCMA software technology reduced medication errors by 50% on average (41.4% to 55.4%). Therefore, P_1 of .33 and P_2 of .165 were used respectively. Equal charts were reviewed for both pre-BCMA and post-BCMA timeframes, therefore r = 1. To ensure an adequate amount of data was collected, an additional 11 charts per timeframe were reviewed. This resulted in a total sample size of 258 charts for the study. Patient records reviewed for the study consisted of patients who had medication(s) ordered to be administered within the ED prior to patient transfer to an inpatient unit at a VA Medical Center.

I selected a confidence interval of 95% which suggests that there will be a 95% probability that the interval contains the population parameter and that there is a 5.0% risk that the population parameter is not contained within the interval (Frankfort-Nachmias & Leon-Guerrero, 2015). A lower limit and an upper limit will represent a range of values that will represent the true population parameters with a specific level of confidence (Frankfort-Nachmias & Leon-Guerrero, 2015). A sample size estimation for

proportion (Shuster, 1990) was used to estimate the number of patient records needed to obtain results for this study's targeted population.

Generalizable ED medication error data collected before BCMA implementation in the Fall of 2107, consisted of 129 patient records for patients that were observed in the ED, ordered medication to be administered within the ED before transferring to an inpatient unit within the VA Medical Center. Then, a 6-week adjustment period (allowing for stabilization to occur after BCMA software technology had been implemented) lapsed before collecting 129 records for patients that were observed in the ED, ordered medication to be administered within the ED before transferring to an inpatient unit within the VA Medical Center.

Data Collection

This research was conducted by reviewing patient charts and the CDW, generated through an EDIS query. Medication orders were reviewed to determine if medication errors occurred for patients who were initially seen in the ED, had medications ordered to be administered within the ED then transferred to an inpatient unit.

BCMA software technology was implemented in the ED at the VA Medical Center where this study took place in the Fall of 2017. I used a SQL inquiry to extract data from the CDW to include records of patients that were observed in the ED and ordered to receive medication in the ED before transferring to an inpatient unit.

A SQL query was executed by using "SELECT" statements. SELECT statements specify which columns the needed data are extracted from within the database (Zentut, 2020). The select statements used before BCMA software implementation were patient

name, patient social security number, entered date time, and orderable item name. A SQL query can be more specific, with the help of several clauses such as ORDER BY (this clause sorts results so as not to be in random order), FROM (indicates the table where the search will be made), and WHERE (used to define rows in which the search will be carried. The study "FROM" statement is the CPRS order and the "WHERE" statement is the VA Medical Center location number. Records of patients that had medication order(s) to be administered in the ED before patient transfer within this VA Medical Center prior to the start date of BCMA use in the Fall of 2017 were obtained until a total of 129 patient records are identified.

Next, I identified the date range for the collection of 129 patient records, contacted quality management and requested patient safety hotline and JPRS medication error submissions within this time. I was informed by quality management safety officer that no submissions were received during my study timeframe. Then, I began to enter the data within SPSS. I started labeling the chart before BCMA technology implementation as Chart A. Then I identified patient records by entering numerical values of 1-129 (number of patient records needed to reflect the target population for this study) dating backward from the start date of BCMA implementation in the ED at this facility in the Fall of 2017. Medication errors that were reported through the patient safety hotline and JPRS submissions would have been recorded with the letter *J* and medication analyzed within CPRS were recorded with the letter *C*. Medication events for patients that were seen in the ED, ordered to receive medication(s) in the ED then transferred to an inpatient

unit were identified as WME or WOME indicating whether there was or was not a medication error for the total of 129 patient records.

The second SQL query conducted was to identify patients who had medication(s) ordered to be administered within the ED prior to transferring to an inpatient unit after BCMA software technology was implemented within the ED. The select statements used included patient name, patient social security number, patient location, action date/time, staff name, pharmacy orderable item, action status, order schedule, scheduled administration date time, and BCMA medication log comment. The study "FROM" statement is BCMA and the "WHERE" statement is the VA Medical Center location number. Records of patients that had medication order(s) to be administered in the ED prior to patient transfer within the VA Medical Center after the six-week stabilization period, were collected until a total of 129 patient records were identified.

Next, I identified the date range for the collection of 129 patient records, contacted quality management and requested patient safety hotline and JPRS medication error submissions within this time. I was informed by quality management safety officer that no submissions were received during the period of the post-BCMA study timeframe. Then, I began to enter the data within SPSS. I started labeling the chart after BCMA technology implementation as Chart B. Then I identified patient records by entering numerical values of 1-129 (number of patient records needed to reflect the target population for this study) to identify patient records after the six-week stabilization period when BCMA was implemented in the ED at this facility in the Fall of 2017. Medication errors that were reported through the patient safety hotline and JPRS

submissions would have been recorded with the letter *J* and medication analyzed within CPRS were recorded with the letter *C*. Medication events for patients that were seen in the ED, ordered to receive medication(s) in the ED then transferred to an inpatient unit were identified as WME or WOME indicating whether there was or was not a medication error for the total of 129 patient records. Medication errors of omission during this timeframe were also recorded as medication errors within SPSS.

- Example 1: If the 45th patient viewed before BCMA implementation had a medication error that was reported in JPSR the column would read: A 45 J WME.
- Example 2: If the 45th record was reviewed in CPRS after BCMA implementation, and the patient did not have a medication error, the column would read B 45 C WOME.

Data Access

All researchers must ensure patient privacy. IRB approval is needed before researching with human subjects whose information has been obtained by the investigator through intervention or interaction and the information is used, studied or analyzed or may generate identifiable private information about the human subject. Research data may only be conducted after receiving approval or exempt status from the IRB at the facility in which the research is being completed. The information must be obtained with accuracy, without bias and proper authorization must be received from the organization.

Before beginning this research, I extended a formal written request to the IRB at the Medical University, the teaching facility which is affiliated with the VA medical center where research is taking place. After obtaining approval to conduct the study from

the university IRB, I submitted the approved documents to the VA Medical Center R&D Committee. The R&D committee reviewed and approved the study. Next, I submit all approved documentation for the research study from the Medical University and the R&D committee to the Research Office at Walden University. Finally, after Walden University reviewed and acknowledged this study, I began to collect and analyze data for the research study. I maintained strict privacy to protect patient information.

I kept research information within a folder on a VA Medical Center portal throughout the study. This folder is password protected which means access is only granted by those individuals with permission to open it. The three individuals with permission to access the folder containing the research study information are the director and chief nurse of the HEROIC program and myself.

Instruments and Instrumentation

Access to JPSR system identifies medication error events that occurred within the ED for patients who were to receive medication in the ED then transfer to an inpatient unit within the VA Medical Center. Access to CPRS software identifies patients observed in the ED, had medication ordered to be given in the ED and then transferred to an inpatient unit. Information needed to identify information for CPRS chart reviews was extracted from the CDW by using SQL software. The following SQL inquiry identified medication(s) ordered and medication(s) administered within the ED.

The SQL “SELECT” statements used before BCMA software implementation were patient name, patient social security number, entered date time, and orderable item name. The "FROM" statement used was CPRS order and the "WHERE" statement used

was the VA Medical Center location number. Records of patients that had medication order(s) to be administered in the ED before patient transfer within this VA Medical Center before the start date of BCMA at this facility in the Fall of 2017, were obtained until a total of 129 patient records were identified.

The second SQL query conducted was to identify patients who had medication(s) ordered to be administered within the ED prior to transferring to an inpatient unit after BCMA software technology was implemented within the ED. The “SELECT” statements used included patient name, patient social security number, patient location, action date/time, staff name, pharmacy orderable item, action status, order schedule, scheduled administration date time, and BCMA medication log comment. The study "FROM" statement is BCMA and the "WHERE" statement is the VA Medical Center location number. Records of patients that had medication order(s) to be administered in the ED prior to patient transfer within the VA Medical Center after a six-week post-BCMA stabilization time period were collected until a total of 129 patient records were identified.

Basis for Development

When a facility uses BCMA software in the inpatient units but not the ED, a lack of consistency within the EHR may exist, creating an interruption within the patient's record of care (Glover, 2013). The lack of continuity within the EHR may cause medication errors (Glover, 2013). A gap in the literature exists regarding medication error rates for patients who had been prescribed medication to be administered in the ED then transferred to an inpatient unit (Glover, 2013) which warrants the need for research to be

conducted. This research study provides useful information regarding medication error rates and administration documentation practices by comparing the difference between documenting medication administration within an electronic nursing note located within CPRS or using BCMA software system, for patients who have been ordered to receive medication in the ED and then transfer to inpatient units at the VA Medical Center where this study took place.

Reliability

All data for this study has been collected from the CDW and CPRS software chart reviews. I have used a unique reference code for each category within the SPSS research database. Coding before BCMA implementation as Group *A* and after BCMA implementation as Group *B*. A sample size estimation for proportion (Shuster, 1990) was used to estimate the number of patient records needed to obtain results which will reflect the target population for this study. Therefore, patient records are numbered 1-129 before BCMA software technology implementation and 1-129 after BCMA software implementation. Patient records are allocated into two different categories, WME and WOME. The medication error category specifies whether the information was obtained from the patient safety hotline or JPSR, which has been signified with the letter J or if the error information was a review within the CPRS, which is signified with the letter C. All collected data has been electronically stored in a password protected designated research file which is only accessible by the director and chief nurse of the HEROIC program office of the VA Medical Center where this study took place.

I have compared the outcome of this study with similar study outcomes and identified the retest correlation which indicates this study is reliable. According to Noble and Smith (2015), a measure has high reliability if it produces similar results under consistent conditions. Reproducing values by measuring the same subjects twice or more (retest reliability) is the most used test for reliability of measures (Hopkins, 2000). A retest correlation of 1.00 represents a perfect agreement between studies and 0.00 represents no agreement (Hopkins, 2000). Most statisticians agree that a study with 0.95 or higher correlation represents a highly reliable study (Hopkins, 2000).

Validity

Reliability is the first requirement for a study to be valid (Kaplan & Saccuzzo, 2005). When another researcher can produce similar results by using the same instrument as the work of a previous investigator, the research is said to be reliable (Vaida, Lamis, Smetzer, Kenward, & Cohen, 2014).. To sustain reliability, research must be generalizable (Vaida et al., 2014). Rliability issues are associated with subjectivity (Noble & Smith, 2015). When an investigator utilizes a subjective approach, the level of reliability of the work may be compromised.

The research conducted within this study has been obtained objectively and without bias by using nationally supported tools. Therefore, this study is considered a highly reliable research study. The three systems used to collect data for this study were patient safety submissions report, JPSR submissions, and CPRS record reviews.

To create and sustain a high-reliability organization, staff must be confident that they will not be reprimanded for reporting errors (Agency for Healthcare Research and

Quality, n.d.). Staff reported errors anonymously by calling the patient safety hotline or completing a JPRS submission. Allowing the staff to report errors without repercussions helps improve care by analyzing why the error occurred and how a process can be changed to lessen the chances for the error to reoccur providing staff the ability to continuously improve and deliver the safest patient care possible.

The patient safety hotline is a method used to report safety issues (including medication errors) at this location. All reported medication errors are reviewed by the patient safety coordinator and documented within an excel spreadsheet. This spreadsheet is kept in a password protected firewalled server folder. The JPSR system was initiated into this facility in the Winter of 2018. Administration and end-users are able to report patient safety events by submitting an electronic JPSR. These reports are collected by the quality management team and reviewed by the facility medication aggregate review board. The board is comprised of physicians, nurses, and pharmacists. Therefore, the information collected from the JPSR submission is a reliable form of data collection.

The third system used to collect data was the examination of patient records by reviewing patient records within CPRS. CPRS is the CPOE software used within the VA Medical Centers throughout the United States. CPRS is a nationally recognized stage 7 software system (Healthcare Information and Management Systems Society, 2017).

Healthcare Information and Management Systems Society (HIMSS) is a global advisory group of healthcare leaders that support the revolution from paper documentation to electronic charting. HIMSS has developed an Analytics tool, Electronic Medical Record Adoption (EMRA) model which is used to score facilities according to

how they have adopted and use their EHR system. The EMRA model has eight-stages (0-7) of measurement. The measurements range from stage 0, no installation of any of the three key ancillary department systems (laboratory, pharmacy, and radiology) to stage 7, the hospital manages patient care by documenting within an EHR. The EHR is used to manage patient care and has a mixture of discrete data, document images, and medical images within its EHR environment (HIMSS, 2017). Stage 7 indicates 90% of the physician documentation and order entry is used within the facility and closed-looped patient care methods are used for 95% of the facility hospital. Each stage obtained enables the facility to advance one step closer to a paperless environment which increases the ability to provide safer patient care (HIMSS, 2017). However, the ED is excluded from this EMRAM stage-related criterion (HIMSS, 2017).

Operationalization

The research study was conducted to investigate if a relationship exists between the DV, medication error, and the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit. The use of scannable barcodes is the foundation of BCMA software technology. After identifying the variables within a study, the researcher needs to measure each variable and express its value. The way a variable is measured in a study is called the operational definition (Gray et al., 2017). Defining a variable is a critical step in the research process as it provides credibility to the methodology, helps to control the variable (by making the measurement constant) and

ensures reproducibility of the study result (Gray et al., 2017). Operational definition of the research study variables are as follows:

Medication error: Medication error is defined by the United States National Coordinating Council for Medication Error Reporting and Prevention (2015) as

> any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing, order communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use. (para 1).

A medication administration error may consist of giving an incorrect dose, incorrect route, incorrect time, administering the wrong medication, or not administering a medication that was ordered to be given.

Documenting medication administration in an electronic nursing note located in CPRS (Not using BCMA technology within the ED): The period when this VA Medical Center did not use BCMA software technology to document medication administered to a patient within the ED. During this time, the process for medication administration included: the nurse logged in to a computer on wheels using their personal username and password, signed in to CPRS using their personal username and password, identified patient from the populated ED patient list in CPRS, viewed medication order(s) for an individual patient under the order tab in CPRS, and obtained the ordered medication from

the automated drug dispenser which is located in a locked room within the ED. Then, the nurse took the computer on wheels along with the medication to be administered and entered the patient room. Upon entering, the nurse requested the patient state their full name and full social security number. The nurse compared what the patient stated to what was displayed in the opened record to assure the patient they were caring for was the same as the patient identified within the opened record. After reviewing the medication(s) with the patient, the nurse administered the medication(s) to the patient and assured the medication was ingested. Finally, the nurse created an electronic nursing note under the notes tab in CPRS and documented the drug name, dose, route, and time the drug was given.

Using BCMA technology within the ED: The period when this VA Medical Center used BCMA software technology as a form of documenting medication administration within the ED. During this time, the process for medication administration included: the nurse logged in to a computer on wheels using their personal username and password, signed in to CPRS using their personal username and password, identified patient from the populated ED patient list in CPRS, viewed medication order(s) for an individual patient under the order tab in CPRS, and electronically verified the medication(s) to be given. The nurse obtained the ordered medication from the automated drug dispenser which is in a locked room within the ED. Then, the nurse took the computer on wheels along with the medication to be administered and entered the patient room. Upon entering, the nurse signed in to BCMA using their personal username and password, scanned the patient wristband (which populates the individual patient electronic

medication administration record), requested the patient state their full name and full date of birth (or two other patient-specific identifiers), and compared what the patient stated to what was displayed in BCMA to assure the patient they were caring for was the same as the patient identified within BCMA. After reviewing the medication(s) with the patient, the nurse scanned the medication(s). Scanning the medication(s) automatically documented the medication ordered time, dose, and the route of administration in to BCMA. Finally, the nurse, administered the medication to the patient and assured the medication was ingested. If the nurse attempted to scan a medication that was not ordered to be given a warning message displayed in BCMA and the medication would not scan.

Data Analysis Plan

The outcome of this study was dependent on the analysis of the medication administration data. I used the SPSS software version 25 as the data depository. SPSS is a statistical platform that offers a variety of algorithms as forms of analysis. I assigned the time before BCMA software technology implementation in the ED as Group *A* and after BCMA software technology implementation in the ED as Group *B*. A sample size estimation for comparing two proportions (Shuster, 1990) was used to estimate the number of patient records needed to obtain results which identified the target population for this study. Therefore, patient records were numbered 1-129 before BCMA software technology implementation in the ED and 1-129 after BCMA software technology implementation in the ED. Patient records were allocated into two different categories, WME and WOME. The medication error category specified the information obtained

from the patient safety hotline or JPSR, which was signified with the letter *J* or if the error information was a reviewed within the CPRS, and signified with the letter *C*.

Data analysis consisted of analyzing information entered into the SPSS software system (data collection) using the Chi-square test of independence. For the Chi-square test, a bivariate table presents the distributions of two categorical variables simultaneously, with the intersections of the categories of the variables appearing in the cells of the table (Number Crunchers Statistical Software, n.d.). The Chi-square is used to assess whether an association exists between the two variables by comparing the cell pattern of the observed counts to the anticipated pattern that is expected if no relationship exists between the variables (Number Crunchers Statistical Software , n.d.). The result of the Chi-square compared against the value from the Chi-square distribution allows the researcher to assess whether the observed data are significantly different from the expected data (Number Crunchers Statistical Software, n.d.). All cells had an expected frequency value of 5, which validates no violation of the Chi-square test assumption. Chi-squared statistics were used to determine if a difference in medication errors exist between documenting medication ordered to be administered in the ED by using an electronic nursing note in CPRS and documenting medications ordered to be administered in the ED by using BCMA software technology.

Research Question and Hypothesis

RQ1: What is the comparison in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA

technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit?

H_0: There is no relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

H_a: There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

A hypothesis is an assumption that the researcher will try to answer within the study. The first hypothesis is the null hypothesis or H_0. The researcher does not expect the null hypothesis to be true. The second hypothesis is the alternative hypothesis or H_a. The researcher assumes the alternative hypothesis is true. At the end of a quantitative research study, the researcher will either accept or reject the null hypothesis.

Statistical Testing

This study is a quantitative nonexperimental comparative descriptive research design used to explore whether documenting medication administration in BCMA mitigates medication error rates for patients who are seen in the ED, ordered to receive medications in the ED and then transfer to an inpatient unit. Quantitative research designs are often used to investigate causal relationships but may also be used to investigate relationships between variables (Gray et al., 2017). The study conducted is a descriptive

design because the data has not been manipulated, and no interventions or treatments were made to the information obtained for the population studied. Descriptive designs are considered nonexperimental. A comparison was made to examine whether a relationship exists between the DV, medication error, and the IVs, using an electronic nursing note located within CPRS or using BCMA software technology to document medications administered within the ED prior to patient transfer to an inpatient unit. I used Chi-square statistics to identify the comparison between the DV and IVs. Therefore, I conducted a quantitative nonexperimental comparative descriptive research design using Chi-square statistics to identify whether the use of BCMA in the ED mitigates medication errors for patients that were prescribed medication to be given in the ED before transferring to an inpatient unit within the VA Medical Center where this study took place.

Data analysis consisted of analyzing information entered into the SPSS software system (data collection) using the Chi-square test of independence. For the Chi-square test, a bivariate table presents the distributions of two categorical variables simultaneously, with the intersections of the categories of the variables appearing in the cells of the table (Number Crunchers Statistical Software, n.d.). The Chi-square is used to assess whether an association exists between the two variables by comparing the cell pattern of the observed counts to the anticipated pattern that is expected if no relationship exists between the variables (Number Crunchers Statistical Software , n.d.). The result of the Chi-square compared against the value from the Chi-square distribution allows the researcher to assess whether the observed data are significantly different from the expected data (Number Crunchers Statistical Software, n.d.). All cells had an expected

frequency value of 5, which validates no violation of the Chi-square test assumption. Chi-squared statistics were used to identify the comparison of medication errors between documenting medication ordered to be administered in the ED by using an electronic nursing note in CPRS and documenting medications ordered to be administered in the ED by using BCMA software technology.

Threats to Validity

Threats to the internal validity of this study are twofold. The first threat to validity is the accuracy of provider documentation. Proper documentation from healthcare professionals cannot be stressed enough. Correctly documenting medication administration may result in poor patient outcomes, liability issues for the institution, and may have a negative impact on the provider involved in the documentation process (Seibert, 2014). However, mistakes do happen, and EHRs can have incorrect information. The second threat to internal validity is the accuracy of medication error reporting. Research has demonstrated that self-reporting medication errors are likely underreported (Etchegaray & Throckmorton, n.d.; Rishoei et al., 2017). Reporting was significantly higher when a potentially fatal medication error was found (Jember, Hailu, Messele, Demeke, & Hassen, 2018).

Threats to external validity involve the ability to generalize the results of this study. The lower the significance level, the more probable the results. This study involves the collection of data for one VA Medical Center located in the Southeastern United States. Therefore, this study may not be generalizable to the entire population.

Threats to the study hypothesis may relate to patient and provider trustworthiness. Relational continuity exists when a patient and provider share accurate patient-specific information (Cacchione, 2016). A threat exists if a patient does not ingest the medication that was to be administered. The record (either electronic nursing note in CPRS or BCMA software technology) would indicate the medication was administered when, in fact, the patient did not ingest. Therefore, the record would not accurately reflect actual events.

Ethical Considerations

Permission to conduct this research was approved by the VA Medical Center R&D committee and affiliated Medical University IRB where this study took place. The VA Medical Center R&D and Medical University IRB approval number for this study is Pro00092261. The Walden University IRB confirmed that this study met Walden University's ethical standards. The Walden University IRB approval number for this study is 01-27-20-0175627. No patient identifiable information was or will be shared within the study results. All collected data has been electronically stored in a password protected designated research file which is only accessible to the director and chief nurse of the HEROIC program office of the VA Medical Center and me. Data will be stored within this file for a total of 7 years at which time the file will be destroyed or archived within VA Medical Center data warehouse.

Summary

A quantitative nonexperimental comparative descriptive research design was used to examine the comparison between medication error rates when an electronic nursing

note is used to document medication(s) given compared to using BCMA software to document medication(s) given to patients who were ordered to receive medication(s) in the ED before transferring to an inpatient unit within the VA Medical Center located in the Southeastern United States. A Chi-squared statistical test has demonstrated whether the use of BCMA technology in the ED mitigated medication error rates for patients who were observed in the ED, had medication orders to be administered within the ED, then transferred to an inpatient unit. The results of this quantitative case study design will be discussed in the following chapter.

Chapter 4: Results

Introduction

The purpose of this study is to investigate whether medication errors decrease after documenting medication administration within an electronic nursing note was replaced by documenting medication administration by using BCMA software technology. Specifically, the study was designed to address the following research questions:

RQ1: What is the comparison in medication error rates between documenting medications given by using an electronic nursing note as compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit?

H_0: There is no relationship in medication error rates between documenting medications given by using an electronic nursing note as compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

H_a: There is a relationship in medication error rates between documenting medications given by using an electronic nursing note as compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

Chapter 4 chapter begins with a description of the data processing procedures conducted before the analysis, followed by a report of descriptive statistics for the

sample. The data analysis and results of the research question are then presented. Finally, this chapter concludes with a summary.

Data Collection

The sample size for this study was estimated by proportional measures. With significance level α=0.05, equal sample size from two proportions (r=1), the probability $p_1 = 0.33$ and $p_2 = 0.165$ are considered sufficiently different to warrant rejecting the hypothesis of no difference. Then the required sample size for two arms to achieve an 80% power ($\beta = 0.2$) can be determined by (total chart review) $M = 118$, $N = 236$.

BCMA software technology was implemented in the ED at this facility in the Fall of 2017. Pre-BCMA data collection consisted of extracting patient records for review before the start date of BCMA in the Fall of 2017, until 129 records of patients ordered to receive medication in the ED before transferring to an inpatient ward at this facility was achieved. A stabilization period of 6-weeks (Gibson, 2013) was allowed after the BCMA software system had been established. Therefore, I collected post-BCMA records starting after BCMA had been implemented in the ED for a six-week stabilization period.

I reviewed the EDIS data, which is stored in the CDW to identify patients who were seen in the ED and had orders to administer medication in the ED before transferring to an inpatient unit at this facility. To assure the recommended number of charts would be identified, a total of 193 records were extracted for pre-BCMA data collection. The records within the EDIS also included patients who were seen in the ED and discharged home or to another facility, therefore a review of each record, starting

with the last day prior to the start date of BCMA in the Fall of 2017, was conducted until a total of 129 records of patients who were seen in the ED, ordered to receive medication in the ED and transferred to an inpatient unit at this facility were identified. Next, I reviewed data, which was extracted data from the CDW, for post-BCMA implementation. Dates were chosen to allow for a stabilization period. The stabilization period is the time allowed between a new system install and when end-users become proficient and comfortable using the new system (Gibson, 2013). To assure the recommended number of charts would be identified, a total of 195 records were extracted for post-BCMA data collection. Finally, I reviewed each record starting with the last day of the stabilization period, until 129 records of patients that were seen in the ED, ordered to receive medication in the ED and transferred to an inpatient unit at this facility were identified.

Discrepancies in Data Collection

In Chapter 3, I described the process of data collection to begin with a SQL tool used by extracting data from the CDW for patient records. However, after reviewing the data collected using the SQL application, I noticed the data was difficult to interpret and manipulate. Deciphering between patients who were seen and discharged home or to another facility and patients who were seen, had medication ordered to be administered in the ED before being admitted to a unit at the facility was difficult. Sorting and manipulating the SQL data query was very labor intensive which led me try the EDIS system to extract data for this study. The EDIS system manages ED patient care electronically. By reporting patient status information systems within the electronic

program, the EDIS application has improved the accuracy of patient transfer information within the ED (Department of Veteran Affairs, 2019).

To identify pre-BCMA software implementation data, dates were entered to retrieve 129 patients who were seen in the ED, had an order to receive medication while they were in the ED before transferring to an inpatient ward prior to the implementation of BCMA in the ED at this facility in the Fall of 2017. After identifying the facility by entering the VISN number and station number within the EDIS application, data from the CDW automatically populated into the VA Admissions Report. EDIS data extraction method was completed for both pre and post BCMA software usage. The data collection consisted of the VISN number, station number, ED code, patient name, patient social security number, time out, complaint, medical doctor, acuity, admission decision time, admission delay time, disposition, internal classification of disease code and diagnosis. The data was extracted from the CDW database using the VA admissions report. The use of the EDIS application demonstrated an improvement in the accuracy of ED to ward admissions compared to the data collected with the SQL application. The data extracted from EDIS was easier to interpret and manipulate than previously used SQL application extraction.

Descriptive and Demographic Characteristics

To identify data for the pre-BCMA software implementation, 193 patient records were captured. I sequentially reviewed each patient record, starting with the day before BCMA technology was implemented in the ED at this facility in the Fall of 2017 until 129 patient records were identified as having or not having medication errors. A total of

136 patient charts were reviewed. Patient records for the post-BCMA software implementation totaled 195 patient records. I sequentially reviewed each patient record starting with the day after the six-week stabilization period until a total of 129 patient records were identified as having or not having medication errors. A total of 140 patient charts were reviewed. The process of reviewing each record assured that the 129 pre-BCMA patient records and 129 post-BCMA patient records only included those patients that were seen in the ED, ordered to receive medication in the ED and transferred to an inpatient unit. A patient that was seen in the ED and was transferred to another facility or discharged home was not included in this study. The dataset included a total of 258 patient records.

External Validity

Threats to external validity involve the ability to generalize the results of this study. The lower the significance level, the more probable the results. This study involves the collection of data for one VA Medical Center located in the Southeastern United States. Therefore, this study may not be generalizable to the entire population. Threats to the study hypothesis may relate to patient and provider trustworthiness. Relational continuity exists when a patient and provider share accurate patient-specific information (Cacchione, 2016). A threat exists if a patient does not ingest the medication that was to be administered. The record, either an electronic nursing note or the use of BCMA technology, would indicate the medication was administered when, in fact, the patient did not ingest. Therefore, the record would not accurately reflect actual events.

Results

The final sample for this study consisted of 258 patient records. Medication errors were present in 27.9% of 129 patient records reviewed during the time that an electronic nursing note was used to document medication administration. Medication errors were present in 17.1% of 129 patient records reviewed after BCMA software technology was implemented in the ED. This results in an observed 10.8% difference in medication errors between pre-BCMA and post-BCMA software implementation. (see Table 1).

Table 1

Medication Administration Error Rate

	Pre-BCMA	Post-BCMA	Total Records	Pre-BCMA %	Post-BCMA %
With Medication Errors	36	22	129	27.9	17.1
Without Medication Errors	93	107	129	72.1	82.9
Total	58	200	258	100	100

Note. BCMA = Barcode Medication Administration, Pre-BCMA = Before BCMA was implemented in the ED, Post-BCMA = After BCMA software technology was implemented in the ED.

Descriptive Statistics

Descriptive statistics were computed for each of the study variables. The means and standard deviations for pre-BCMA variables are displayed in Table 2. The average number of medications given in error per chart was 0.47 (SD = 0.910). The average number of medications given without error per chart was 2.47 (SD = 1.984).

Table 2

Pre-BCMA Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
With Medication Error	129	0	4	0.47	0.91
Without Medication Error	129	0	12	2.47	1.984

Note. BCMA = Barcode Medication Administration.

The means and standard deviations for post-BCMA variables are displayed in Table 3. The average number of medications given by error per chart was 0.26 (*SD* = 0.668). The average number of medications given without error per chart was 2.68 (*SD* = 1.768).

Table 3

Post-BCMA Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
With Medication Error	129	0	4	.26	.668
Without Medication Error	129	0	11	2.68	1.768

Note. BCMA = Barcode Medication Administration.

Next, I viewed the actual count and the expected count of medication errors that occurred for patients that were seen in the ED, ordered to receive medication in the ED and transferred to an inpatient unit. This data was calculated with the use of SPSS software version 25. The expected amount describes the number of medication errors that

are expected to be found if BCMA use had no relationship with medication errors. The expected count represented is 29 medication errors with or without using BCMA software technology to document medication administration (see Table 4).

Table 4

Charts reviewed for Medication Errors Pre-BCMA and Post-BCMA Use

		With Medication Errors	Without Medication Errors	Total
Pre-BCMA	Actual Count	36	93	129
	Expected Count	29	100	129
	Pre-BCMA Use	27.90%	72.10%	100.00%
Post-BCMA	Actual Count	22	107	129
	Expected Count	29	100	129
	Post-BCMA Use	17.10%	82.90%	100.00%

Note. Pre-BCMA Use = Before BCMA was implemented in the ED, Post-BCMA Use = After BCMA software technology was implemented in the ED.

Chi-square test results are used to determine a comparison between the count results and the expected count. The relation between these variables was significant, $x^2(1, N = 129) = 4.359$, $p = .037$. Therefore, the alternate hypothesis is accepted. There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

Additional Findings

Additional variables presented themselves while collecting data. The first test identified the use of BCMA software after implementation. During the post-BCMA data collection period, when BCMA was to be the only source for documenting medication administration (except during a critically emergent situation), the medication was documented as given in an electronic nursing note. The means and standard deviations for documentation practices are displayed in Table 5. The average medication administration documented within an electronic nursing note was 0.88(*SD* = 0.331). The average medication administration documented using BCMA software technology was .16 (*SD* = .363). The average medication administration documented by using both, an electronic nursing note and BCMA technology was .97 (*SD* = .174).

Table 5

Medication Administration Documented Practices: Descriptive Statistics

	Mean	Std. Deviation	Variance
Electronic Nursing Note	.88	.331	.109
BCMA Technology	.16	.363	.132
Electronic Nursing Note plus BCMA Technology	.97	.174	.030

Note. BCMA = Barcode Medication Administration.

The frequency of documenting medication administration within an electronic nursing note is shown on Table 6. An electronic nursing note was used to document medication administration in 12.4% of patient records and medication administration was not documented within an electronic nursing note in 87.6% of patient records.

Table 6

Electronic Nursing Note Documentation

	Frequency	Percent	Valid Percent
Yes	16	12.4	12.4
No	113	87.6	87.6
Total	129	100	100

Note. Yes = Medication administration documented in an electronic nursing note and BCMA software, No = Medication administration not documented in an electronic nursing note and BCMA software.

The frequency of documenting medication administration using BCMA software is shown on Table 7. BCMA software technology was used to document medication administration in 84.5% of patient records and BCMA software technology was not used to document medication administration in 15.5% of patient records.

Table 7

BCMA Software Documentation

	Frequency	Percent	Valid Percent
Yes	109	84.5	84.5
No	20	15.5	15.5
Total	129	100	100

Note. BCMA = Barcode Medication Administration, Yes = Medication administration documented in an electronic nursing note and BCMA software, No = Medication administration not documented in an electronic nursing note and BCMA software.

The frequency of documenting medication administration using a combination of both, an electronic nursing note and BCMA software, is shown on Table 8. Both BCMA and an electronic nursing note was used to document medication administration in 3.1% of patient records. This type of documentation was not included as a medication error because the medication was documented as given.

Table 8

Combination of using both Electronic Nursing Note and BCMA Software Documentation

	Frequency	Percent	Valid Percent
Yes	4	3.1	3.1
No	125	96.9	96.9
Total	129	100	100

Note. BCMA = Barcode Medication Administration, Yes = Medication administration documented in an electronic nursing note and BCMA software, No = Medication administration not documented in an electronic nursing note and BCMA software.

Another finding within this study included medication documented as given within a nursing note with no accompanying written order for the administration of medication. Six instances were identified before BCMA was implemented (Table 9). Written medication administration orders with corresponding medication administration documentation were present within 95.3% of patient records. Electronic nursing notes identified the administration of medication with no written order in 4.7% of patient records. This type of documentation was identified as a medication error because the medication was documented as given without a written medication order.

Table 9

Pre-BCMA Charts: Documented Medication as Administered with an accompanying Medication Order

	Frequency	Percent	Valid Percent
Yes	129	95.3	95.3
No	6	4.7	4.7

Note. BCMA = Barcode Medication Administration, Yes= Contained medication orders, No=Did not contain medication order, Pre-BCMA = Before BCMA software technology was implemented in the ED.

Two instances of medication documented as given within a nursing note with no accompanying written order for the administration of medication were identified after BCMA implementation (Table 10). Written medication administration orders with corresponding medication administration documentation were present within 98.4% of patient records. Electronic nursing notes identified the administration of medication with no written order in 1.6% of patient records. This type of documentation was identified as

a medication error because the medication was documented as given without a written medication order.

Table 10

Post-BCMA Charts: Documented Medication as Administered with an accompanying Medication Order

	Frequency	Percent	Valid Percent
Yes	129	98.4	98.4
No	2	1.6	1.6

Note. BCMA = Barcode Medication Administration, Yes= Contained medication orders, No=Did not contain medication order, Post-BCMA = After BCMA software technology was implemented in the ED.

Summary

In summary, the pre-BCMA analysis period identified 36 medication errors from 129 patient record reviews and post-BCMA analysis period identified 22 medication errors from 129 patient record reviews. The results of the study revealed an 10.8% decrease in medication errors post-BCMA. Therefore, the alternate hypothesis is accepted. There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit. An additional two elements emerged from this study. The first element identified during the review of post-BCMA implementation was uncovering that nursing staff was using three various methods of documenting medication(s) administered in the ED. The three methods used to document medication

administration were BCMA only (84.5%), an electronic nursing note only (12.4%), and the use of BCMA along with an electronic nursing note (3.1%). The second element was the finding that nurses were documenting medication as given in the ED within the patient record when no medication administration order was written. Medication documented as given with no medication order was discovered in 4.7% of patient records reviewed pre-BCMA and 1.6% of patient records reviewed post-BCMA.

Conclusion

The outcome of this study, and consequent acceptance of the alternative hypothesis, suggests using BCMA technology in the ED mitigates medication errors. This chapter described the setting demographics, data collection methods, data analysis, the results of the study, and additional findings. Chapter 4 also included examples of the studies evidence of validity. Chapter 5 will further describe an interpretation of the study findings, limitations, recommendations, potential impact for positive social change, and implications for further research.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to investigate the comparison between using an electronic nursing note or BCMA software to document medication administered within the ED and subsequent medication error rates. This chapter provides a summary, conclusion, and recommendations derived from the findings in Chapter 4. The discussion will be presented by examining the research question as well as significant findings that emerged while analyzing the main hypothesis. Next, a summary of the significant findings followed by a discussion of these findings will be presented. Chapter 5 discussions will include references to previous and current research, limitations incurred during the analysis, implications for social change, and suggestions for improvements in teaching and learning.

The final sample for this study consisted of 258 patient records. Medication errors were present in 27.9% of 129 patient records reviewed during the time that an electronic nursing note was used to document medication administration. Medication errors were present in 17.1% of 129 patient records reviewed after BCMA software technology was implemented in the ED. This results in an observed 10.8% difference in medication errors between pre-BCMA and post-BCMA software implementation.

Before BCMA software technology was implemented in the ED, the average number of documented medications given in charts that had medication errors was 0.47 (SD = 0.910). The average number of documented medications given in charts that had no medication errors was 2.47 (SD = 1.984). After BCMA technology was implemented

in the ED, the average number of documented medications given in charts with medication errors declined to 0.26 (*SD* = 0.668) and the average number of documented medications given in charts without medication errors increased to 2.68 (*SD* = 1.768).

The Chi-square test of independence was performed and revealed that relation between these variables was significant, $x^2(1, N = 129) = 4.359$, $p = .037$. Therefore, the alternate hypothesis was accepted. There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

On the surface, this conclusion is not surprising. Many studies have demonstrated the use of BCMA software has reduced medication errors (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). However, this study has demonstrated that nursing staff did not always follow system procedure for documenting medication administration. After BCMA software technology was implemented to use in the ED, it was to be the only source for documenting medication administration (except during a critically emergent situation). Post-BCMA data revealed medication was documented as given in an electronic nursing note as well as an electronic nursing note and BCMA software combined. During the review of medications documented as given in an electronic nursing note, it was determined that there was no critical necessity for the administration of medication. Nonadherences to system policy may put the patient, nurse and facility at risk.

Another outcome that may jeopardize the safety of the patient, staff and facility was revealed during the data collection phase of this study. Medication was documented within a nursing note as given, however, no medication order was written for the documented medication. This type of error occurred six times during the pre-BCMA data collection phase and twice during the post-BCMA data collection phase.

Interpretation of Findings

Health care facilities that have adopted technology and information systems to improve the medication delivery process have reduced medication error rates by 40% to 70% for hospitalized patients (Shaw et al., 2016). Lack of continuity within the EHR may pose a greater risk for medication errors to occur (Glover, 2013). The most susceptible units for medication errors tend to be high demand units that provide care to patients with more complex and severe diagnoses such as the ED (Medicacao, 2015). BCMA software technology was implemented in the ED at the VA Medical Center for this study in the Fall of 2017.

Successfully transferring patient information from an outpatient setting to an inpatient setting, while sustaining the highest quality care, involves teamwork from all disciplines caring for the patient (Naylor & Berlinger, 2016). Transitional care is a recognized evidence-based approach for improving care provided during patients transitioning between care settings (Hirschman et al., 2015; Naylor, 2000; Rezapour-Nasrabad, 2018). Transitional Care Theory is used to increase outcomes for patients who transfer from one care setting to another (Hirschman et al., 2015). According to Kulshrestha and Singh (2016), transfer documentation is the most important part of the

patient transfer process; however, this documentation is often overlooked because of hastily organized patient transfers.

By documenting medication administered within the BCMA software system, the receiving nurse has access to immediately view all medications administered by the previous nurse (DaSilva & Krishnamurthy, 2016; Kelly et al., 2016; Radwin et al., 2016; Seibert et al., 2014; Shaw et al., 2016; Staggers et al., 2015). However, many facilities have not implemented BCMA technology in their ED (Glover, 2013). BCMA may be considered a component of CoC because providers can immediately view medications documented as administered within the software technology system. By implementing a system to create and sustain CoC throughout the patient care continuum, a facility may have the means to deliver higher quality care and increase the potential for positive patient outcomes. CoC can be considered an antidote to fragmented care by forming the basis for assuring that all providers involved in a patient's care share important clinical information.

Medication Error Rate

Based on the analysis, medication errors declined by 10.8% after BCMA software technology was implemented in the ED at the VA Medical Center where this study took place. The relationship between pre-BCMA ad post-BCMA was significant ($p = .037$) indicating the alternate hypothesis was accepted. There is a relationship in medication error rates between documenting medications given by using an electronic nursing note compared to using BCMA technology for patients ordered to have medications administered in the ED prior to transferring to an inpatient unit.

System Procedures

This study revealed lack of continuity within the patient record system post-BCMA. During this time, BCMA software was to be used to document medication administration. However, only 85% of records were identified as using BCMA technology to document medication administration. This study concluded that 12% of patient records had an electronic nursing note and 3% used both, an electronic nursing note and BCMA technology to document medication administration in the ED before patient transferring to an inpatient unit.

Organization adopt software technology that will facilitate an improved work environment. However, according to Staggers et al., (2015), documenting within BCMA software system may increase the nurse's workload. They write,

> the nurse must use separate applications to follow the required, appropriate mediation administration guidelines and to complete medication administration tasks: CPRS to review/verify orders and BCMA to scan and document medications. New orders must be review in CPRS but can only be scanned and documented in BCMA. Logins for each application are completely separate and complicated, each being a long combination of upper and lower cases, numbers and symbols. To access full application functions while administering medications, users must log into BCMA before logging into CPRS. Typically, nurses have both applications open during medication administration activities. If nurses log into CPRS before BCMA, for example to verify CPRS medications, then

> BCMA functions are limited to read-only, requiring nurses to log out of both systems and log in again before resuming medication scanning or administration. (p. 8)

The nurse choosing not to use BCMA technology to document administered medication could be interpreted as ignoring standardized procedure. Yet, perhaps the organization is unknowingly fostering work processes for documenting medication that increase the nurse's workload.

Also, of significance, both pre-BCMA and post-BCMA medications were documented as given in an electronic nursing note that did not have a provider order to give. This error can only occur when an electronic nursing note is completed because, when using BCMA software technology is used a pharmacist must first review the patient's medication history, clarify medications and dosages are appropriate, and document medication changes to assure all medications taken by the patient are compatible (McNew, 2014). After pharmacy verification the medication will populate within the BCMA software system. Medication that did not have a provider order was documented as administered six times pre-BCMA software technology implementation and twice post-BCMA technology implementation.

System Complexity

Data demonstrated that system procedure was not always followed. Studies have demonstrated BCMA software use in the ED setting as a challenge because nursing staff were identified as performing unsafe workarounds to process patients through their unit quickly (Glover, 2013; Vilena & Jerico, 2015). This study has revealed workarounds for

documenting medication within the EHR. Nursing staff continue to use an electronic nursing note (15%) to document medication administration within the ED. Nurses have stated that using BCMA software technology to document medication administration has disrupted workflow. Ninety-nine BCMA software usability problems were identified of which, approximately 80% involved three individual BCMA software tasks which included administering and charting medications (*n* = 38) 38.4%, congruence with known screen design principles (*n* = 27) 27.3% and preparing medications (*n* = 14) 14.1% (Staggers et al., 2015). Noncompliance on nursing staff with the use of BCMA technology may suggest that the patient and organization is still at risk.

Limitations

This study was conducted at a VA Medical Center located in Southeastern United States. Although BCMA technology is nationally fielded throughout the VA system, the results of this study may reflect user issues with local providers and technological issues established from the local information technology department. Therefore, the transferability of results to another VA Medical Center location may decrease the chance of making the information generalizable to other populations. The VA Medical Center uses an EHR specific to this government entity which may result in dissimilar documentation practices compared to public and private institutions. Accuracy of provider documentation within the EHR is essential for investigative research studies (Kaplan & Saccuzzo, 2005). Mistakes can happen, and EHRs may contain incorrect information which could skew the data collected (Kaplan & Saccuzzo, 2005). The stabilization period for implementing new technology may fluctuate from one hospital

setting to the next (Gibson, 2013). More experienced nurses will be quick to learn and conform to the process while others may feel uncomfortable with technology and work around the system. Data collection timeframe may have occurred during times of environmental variation. The ED is not always chaotic, but when it is, it can be emotionally, physically and mentally draining (Di Simone et al., 2018). The data collected could represent a time of chaos or calm conditions in the ED. Findings from this study indicated medication errors are still occurring, but the study did not address if harm resulted from the medication error.

Recommendations

BCMA software is being used in the ED at the current hospital setting. The study analysis has demonstrated an 10.8% decrease in medication errors after BCMA technology was implemented in the ED. This study results support other previous literature related to the use of BCMA technology and its influence on medication errors. Based on the results of this study, further research is needed to examine the reason medication errors continue to occur as well as the long-term impact of the medication errors.

Consistent documentation practices improve informational CoC for patients transferring from the ED to an inpatient unit. Based on the findings within this study, 15% of patient records were identified as not using BCMA technology to document administered medication within the ED. Studies have demonstrated the use of BCMA software by nursing staff in the ED setting as a challenge (Glover, 2013). ED nurses were identified as performing unsafe workarounds so they could process patients through the

the unit quickly (Glover, 2013; Vilena & Jerico, 2015). To negate unsafe documentation practices, facility leaders must identify current usability problems with medication documentation in the ED. Further research is needed regarding the implementation of EHR systems and the impact it has on provider workflow. Addressing the reasons why varying medication documentation practices are used can affect positive social change which will improve the quality of care and patient care outcomes.

Implications

The study findings have demonstrated the use of BCMA technology in the ED has mitigated medication errors. Documenting medication administration within the same software the inpatient units use provides continuity within the patient record. The facility may deliver higher quality care and increase the potential for positive patient outcomes by using a system that sustains informational CoC throughout the patient care continuum.

Positive Social Change

The potential of positive social change includes assuring that patients do not experience medication errors that could cause significant morbidity or even death. When medication errors occur, it increases the burden on family and friends because the patient requires more care, sometimes for the rest of their life. For the health care organization, the cost of litigation can be staggering. This outcome results in resources (human, financial, etc.) being drawn away from other operational units in the organization. Nurses involved in an error situation may experience frustration and sorrow for the patient. They could be investigated and have their license sanctioned. If the harm to the patient is severe, the nurse can experience guilt for the remainder of their career. As a community

institution, healthcare overall is impacted by medication errors because it fosters distrust and a culture of suspicion by patients, staff, and other stakeholders.

Methodological, Theoretical, and/or Empirical Implications

In a quantitative research study, it is important to acquire information that can be duplicated as well as generalizable. Therefore, the methodology utilized in this study demonstrated to be valuable to determine if the use of BCMA in the ED mitigated medication errors. After data was collected and analyzed, it was determined that the alternative hypothesis was true, suggesting the use of BCMA technology in the ED mitigates medication errors.

Recommendations for Practice

This study contributes to BCMA technology use literature by sharing information regarding continued medication errors after the implementation of BCMA technology. First, it is recommended that the nurse informatics department collect, analyze, and report medication errors to nurse leadership for review. Secondly, it is recommended based on this study's findings that the nurse informaticist shadow nurses in the ED to see what they are experiencing while documenting medication administered. This would provide a greater insight into how the work environment combined with demands of documenting within BCMA software presents a situation that may influence a nurse to choose another form of documentation. Finally, it is recommended that nursing education is provided to ED nursing staff regarding the continuity of documentation practices and the influence it has on patient safety. As identified in this study, the ED environment coupled with the

demands of BCMA software technology are factors serving as barriers to standardization for medication administration documentation practices.

Conclusion

It is the responsibility of all healthcare personnel to provide safe patient care. By providing a more systematic transportation process, Transitional Care Theory and CoC models demonstrate communication strategies for less fragmented care. The lack of appropriate transition of care puts the patient at risk. The results of this study correlate with the current literature regarding the use of BCMA technology within inpatient units. For this study, the use of BCMA in the ED lessened medication errors. However, in addition to concluding the effect of BCMA technology in the ED, a challenge has been identified. The medication administration documentation practices were not consistent. Medication was documented in three various forms: electronic nursing note, BCMA or a combination of both. The study findings suggest further exploration is needed to identify the perception of BCMA software technology and workflow as viewed by ED providers involved in the medication process.

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